An Investigation of the Effect of Streamlining the Blades in a Centrifugal Blower Fan

A THESIS

Presented to the Mechanical Engineering Department of the Georgia School of Technology in Partial Fulfillment of the Requirements for the Degree of MASTER OF SCIENCE in Mechanical Engineering

By

C. A. Short, Jr.

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Approved by

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ACKNOWLEDGEMENT

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Purpose

The purpose of this test was to determine the effect on the performance of a centrifugal fan when using streamlined blades in place of flat steel blades.

Description of Apparatus

The housing of a fifty inch Sturtevant Centrifugal straight blade blower fan was used with a specially designed rotor. The rotor, forged from steel, was machined so as to handle thirty blades, the blades being unrestricted as to their angle with the radius. The rotor held one end of the blades in place and an aluminum ring was used to hold the other end.

To obtain a true comparison between flat and streamlined blades, both types were made to fit in the same rotor. The streamlined blades were cast of aluminum and then finished to proper dimensions by hand. The ideal airfoil cross-section as determined by E. N. Jacobs, Langley Memorial Aeronautical Laboratory, appearing in the N.A.C.A. Technical Notes, No. 385, July, 1931, was used as a guide.

The flat steel blades were shaped from steel of a thickness such as to make both types weigh approximately the same. Their areas were made equal to the projected area of the aluminum blades.

The rotor shaft was supported by two babbitted bearings on one side of the housing and connected by a flexible coupling to an induction motor.

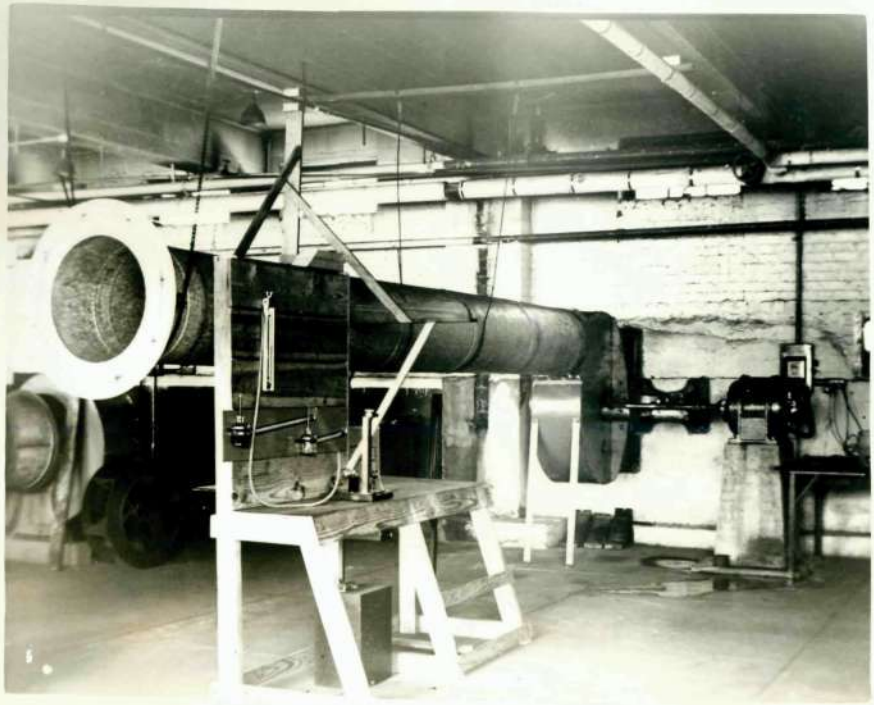
The driving motor was a General Electric, type KT, No. 1470862, twelve pole, 3 phase, 220 volts, rewound and reconnected for desired speed.

The test duct was a circular galvanized steel discharge duct 18.70 inches in diameter and 16 feet long. The length was such as to conform with the A.S.H.&V.E. testing code for centrifugal fans. Eight thin plate orifices with circular openings of approximately equal area increments were used interchangeably at the end of the duct to vary the load on the fan and to measure the quantity of air flowing.

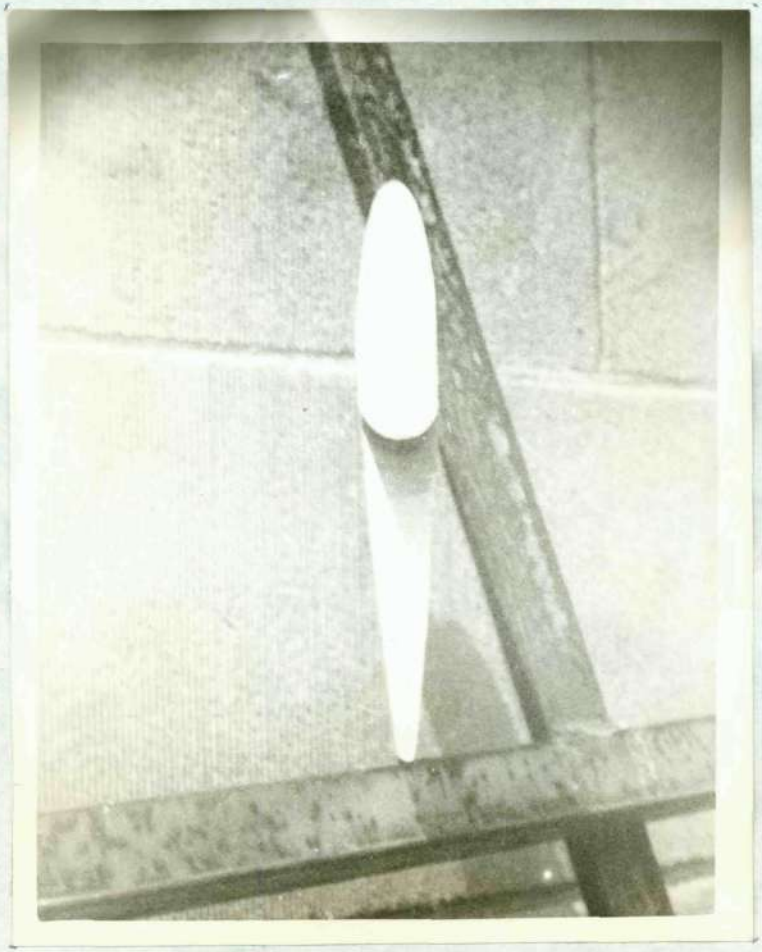
The pressure measuring instrument was a sensitive micro-manometer filled with ethyl alcohol. It is accurate to one thousandth of an inch and can be made as sensitive as desired. It was used to measure the static pressure at a point in the duct two feet before the orifice.

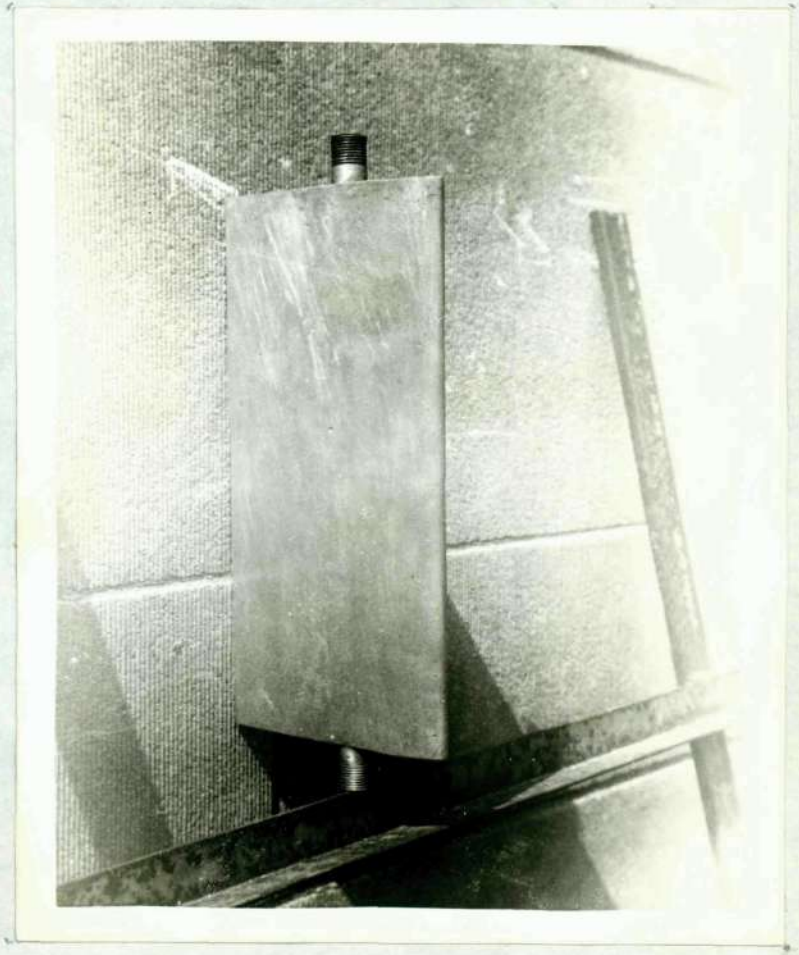
The power measuring instrument was a G. E. wattmeter. Other instruments were: a Starret R.P.M. counter, a stop watch, a sling psychrometer and an aneroid barometer.

THE ROTOR

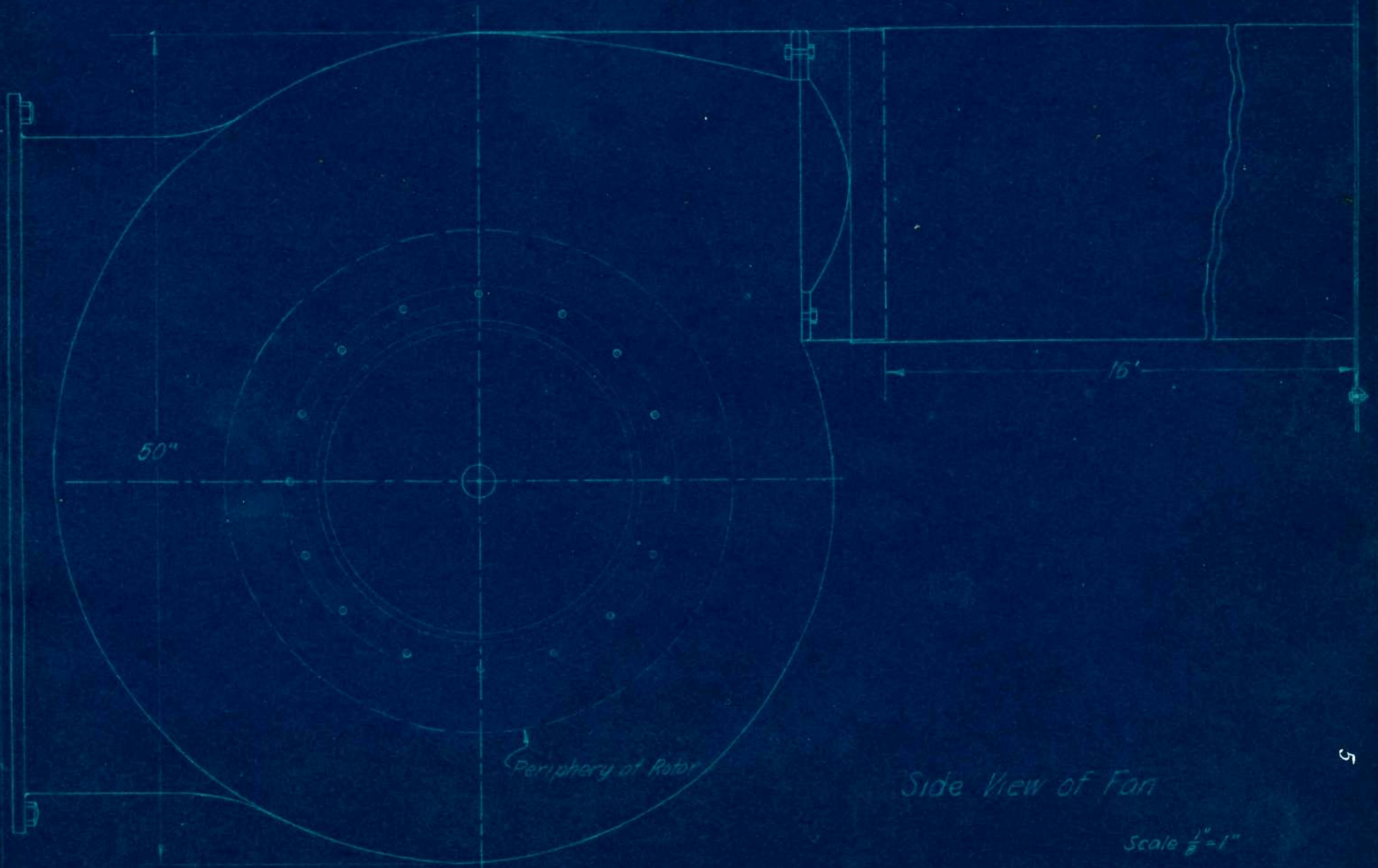


THE TEST SET-UP



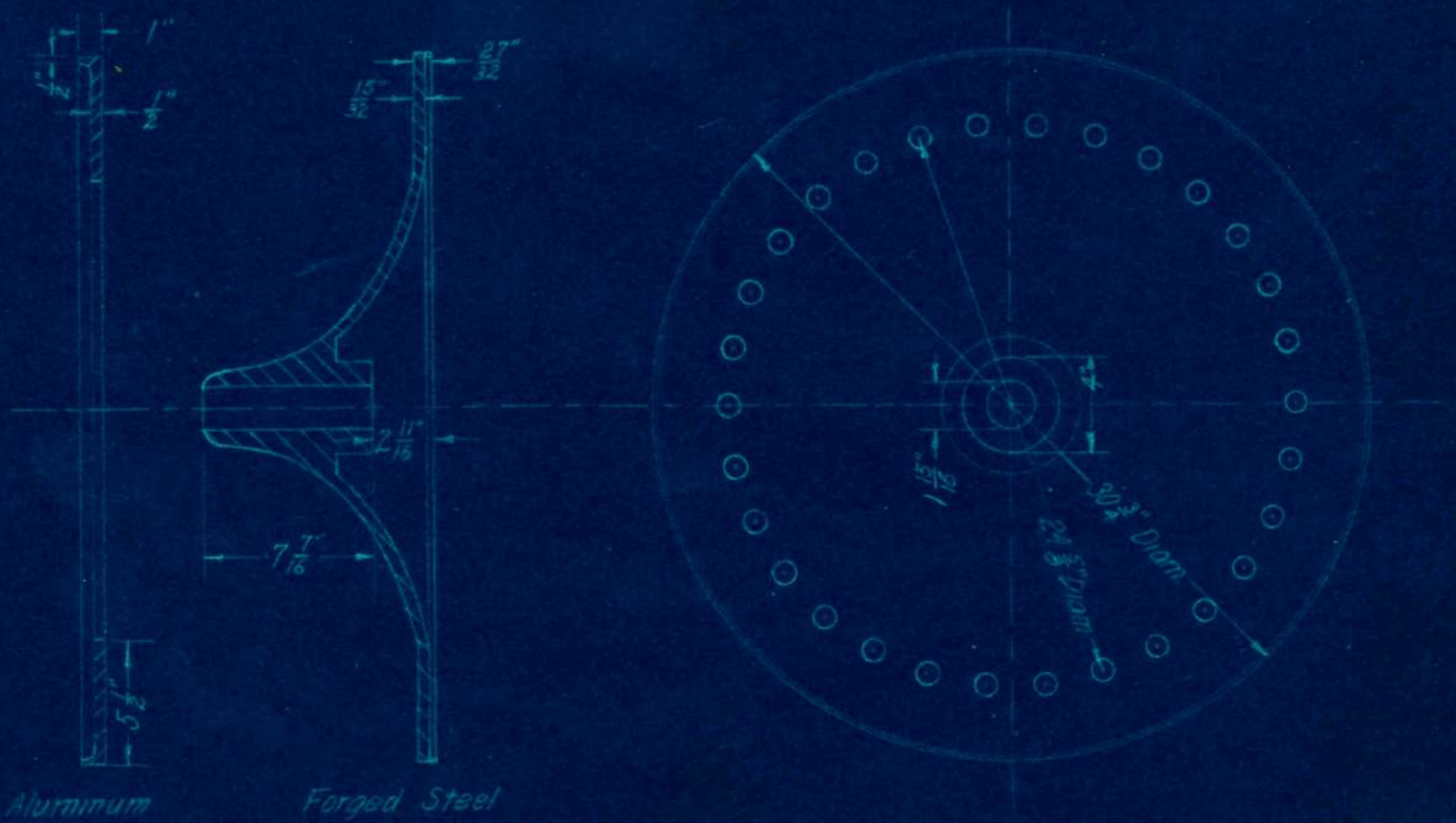


THE STREAMLINED ALUMINUM BLADE



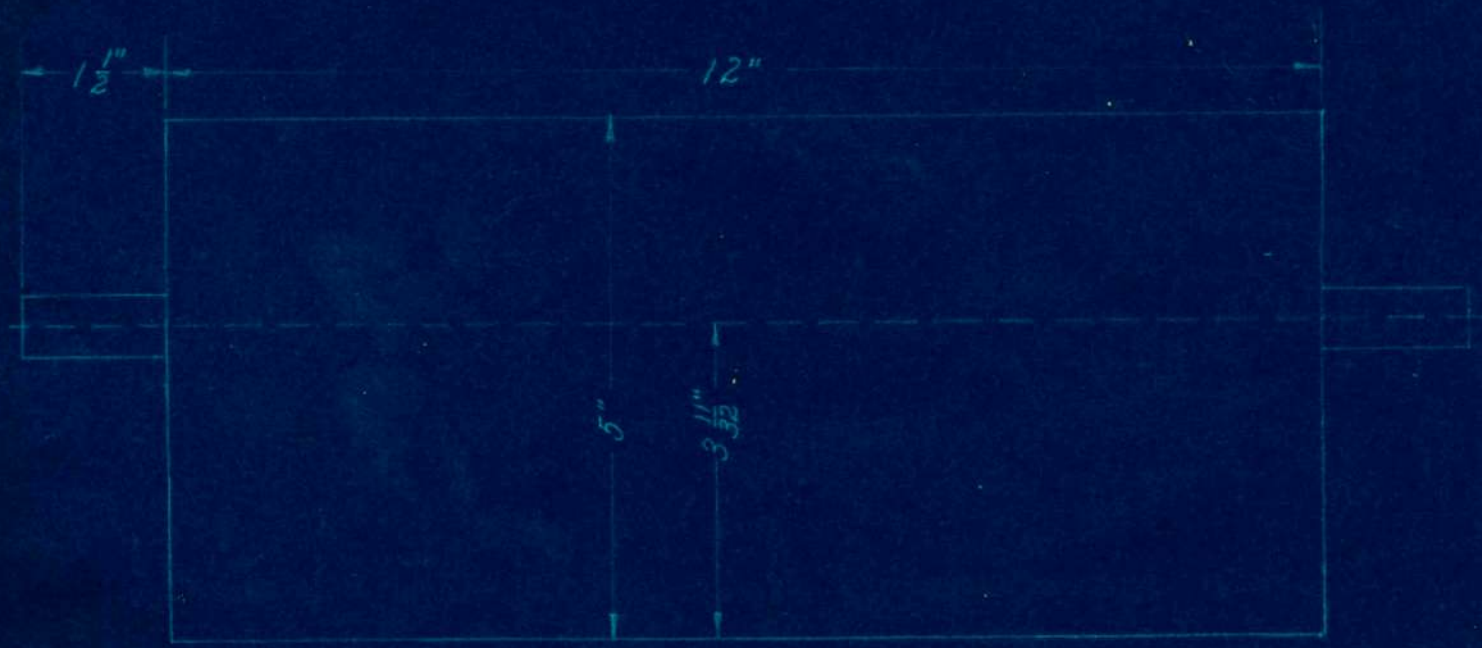
Side View of Fan

Scale $\frac{1}{8}$" = 1"

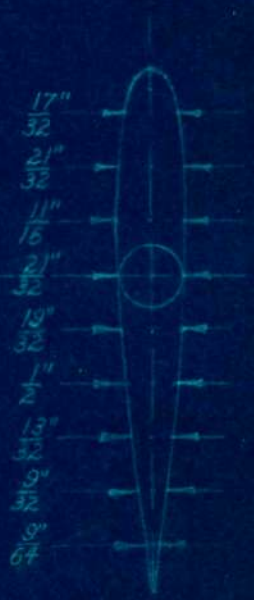


Sketch of Rotor without Blades

Scale 1" = 1"



Aluminum



Thickness at 3/16" Intervals

Sketch of Streamlined Blade

Scale 1"/2 = 1"

Method of Conducting Tests

Identical tests were made with the flat steel blades and the streamlined blades. The number of blades in the rotor were six, ten, fifteen, and thirty. The position of the blades with the radius were zero, ten, fifteen, twenty, twenty-five, and thirty degrees backward angles. For each setting of the blades readings of fan speed, power input to motor, wet and dry bulb, barometric pressure, and static pressure before the orifice openings were taken. The pressure and power readings were observed simultaneously. The conditions of the air in the duct were considered atmospheric as the maximum pressure was not over two inches of water.

The range of fan capacity of prime interest was that in which the maximum efficiency existed. The majority of the runs, therefore, were cut short by using four orifices which would always include the maximum efficiency range.

OBSERVED DATA

6 Streamlined Blades, 10 Degree Back Angle
Nov. 1, 1934 Wet Bulb-66 Dry Bulb-80 Baro.-28.89

Reading Number	Orifice Diameter	Manometer Reading	Speed	Power Input
Units	Inches	"Alcohol	R.P.M.	K.W.
1	Open		577	1.45
2	17.24	0.38	577	1.41
3	16.25	0.61	577	1.39
4	15.25	0.855	578	1.36
5	13.99	1.15	580	1.28
6	12.50	1.46	581	1.17
7	11.50	1.61	582	1.08
8	10.18	1.73	583	0.94
9	7.25	1.90	587	0.71
10	0.00	2.22	589	0.60

6 Streamlined Blades, 15 Degree Back Angle
Nov. 1, 1934 Wet Bulb-56 Dry Bulb-80 Baro.-29.31

1	Open	0.00	576	1.40
2	17.24	0.375	577	1.36
3	16.25	0.605	577	1.34
4	15.25	0.850	578	1.32
5	13.99	1.145	579	1.26
6	12.50	1.44	581	1.15
7	11.50	1.60	583	1.06
8	10.18	1.715	586	0.93
9	7.25	1.905	589	0.70
10	0.00	2.270	590	0.63

6 Streamlined Blades, 20 Degree Back Angle
Nov. 1, 1934 Wet Bulb-66 Dry Bulb-80 Baro.-28.89

1	Open	0.00	576	1.29
2	17.24	0.355	576	1.26
3	16.25	0.57	577	1.26
4	15.25	0.80	578	1.24
5	13.99	1.08	577	1.18
6	12.50	1.36	581	1.08
7	11.50	1.52	581	0.99
8	10.18	1.64	583	0.87
9	7.25	1.825	583	0.68
10	0.00	2.24	589	0.62

OBSERVED DATA

6 Streamlined Blades, 25 Degree Back Angle
Nov. 1, 1934 Wet Bulb-56 Dry Bulb-80 Baro.-29.31

Reading Number	Orifice Diameter	Manometer Reading	Speed	Power Input
Units	Inches	"Alcohol	R.P.M.	K.W.
1	Open	0.00	579	1.26
2	17.24	0.35	579	1.24
3	16.25	0.56	579	1.23
4	15.25	0.79	581	1.21
5	13.99	1.07	582	1.17
6	12.50	1.35	583	1.07
7	11.50	1.50	586	1.00
8	10.18	1.625	589	0.88
9	7.25	1.81	590	0.71
10	0.00	2.28	591	0.67

6 Streamlined Blades, 20 Degree Forward Angle
Nov. 1, 1934 Wet Bulb-65 Dry Bulb-81 Baro.-28.89

1	Open	0.00	566	1.75
2	17.24	0.40	568	1.64
3	16.25	0.64	572	1.58
4	15.25	0.89	574	1.52
5	13.99	1.20	576	1.42
6	12.50	1.52	578	1.28
7	11.50	1.69	579	1.17
8	10.18	1.80	585	1.03
9	7.25	1.93	591	0.76
10	0.00	2.21	592	0.64

OBSERVED DATA

10 Streamlined Blades, Radial
Dec. 13, 1934 Wet Bulb-47.5 Dry Bulb-70 Baro.-29.22

Reading Number	Orifice Diameter	Manometer Reading	Speed	Power Input
Units	Inches	"Alcohol	R.P.M.	K.W.
1	Open	0.002	563	2.16
2	17.24	0.478	567	1.99
3	16.25	0.749	569	1.88
4	15.25	1.027	572	1.76
5	13.99	1.355	575	1.61
6	12.50	1.681	579	1.43
7	11.50	1.844	581	1.29
8	10.18	1.996	583	1.15
9	7.25	2.157	588	0.85
10	0.00	2.329	591	0.67

10 Streamlined Blades, 10 Degree Back Angle
Dec. 13, 1934 Wet Bulb-47 Dry Bulb-69 Baro.-29.22

1	Open	0.000	566	1.85
2	17.24	0.460	568	1.81
3	16.25	0.718	569	1.71
4	15.25	0.971	572	1.59
5	13.99	1.295	575	1.50
6	12.50	1.622	578	1.32
7	11.50	1.778	580	1.26
8	10.18	1.920	582	1.13
9	7.25	2.053	587	0.83
10	0.00	2.240	590	0.65

10 Streamlined Blades, 15 Degree Back Angle
Dec. 18, 1934 Wet Bulb-54 Dry Bulb-72 Baro.-29.05

1	Open	0.003	570	1.7
2	17.24	0.444	572	1.65
3	16.25	0.690	574	1.56
4	15.25	0.942	576	1.49
5	13.99	1.226	578	1.37
6	12.50	1.559	580	1.25
7	11.50	1.695	583	1.12
8	10.18	1.842	584	1.01
9	7.25	1.988	585	0.73
10	0.00	2.091	584	0.56

OBSERVED DATA

10 Streamlined Blades, 20 Degree Back Angle
Dec. 18, 1934 Wet Bulb-54 Dry Bulb-72 Baro.-29.05

Reading Number	Orifice Diameter	Manometer Reading	Speed	Power Input
Units	Inches	"Alcohol	R.P.M.	K.W.
1	Open	0.001	567	1.55
2	17.24	0.410	568	1.47
3	16.25	0.634	570	1.39
4	15.25	0.877	572	1.30
5	13.99	1.168	573	1.22
6	12.50	1.469	574	1.17
7	11.50	1.633	576	1.07
8	10.18	1.740	579	0.95
9	7.25	1.871	581	0.73
10	0.00	2.029	584	0.56

10 Streamlined Blades, 25 Degree Back Angle
Dec. 18, 1934 Wet Bulb-54 Dry Bulb-72 Baro.-29.05

1	Open	0.002	566	1.42
2	17.24	0.394	569	1.36
3	16.25	0.618	573	1.35
4	15.25	0.882	574	1.35
5	13.99	1.152	576	1.26
6	12.50	1.433	578	1.15
7	11.50	1.589	579	1.03
8	10.18	1.727	583	0.92
9	7.25	1.903	589	0.70
10	0.00	2.058	590	0.55

10 Streamlined Blades, 30 Degree Back Angle
Dec. 18, 1934 Wet Bulb-53.5 Dry Bulb-70.5 Baro.-29.01

1	Open	0.001	582	1.38
2	17.24	0.383	583	1.32
3	16.25	0.632	583	1.30
4	15.25	0.858	584	1.27
5	13.99	1.134	585	1.22
6	12.50	1.433	587	1.12
7	11.50	1.577	588	1.03
8	10.18	1.703	591	0.90
9	7.25	1.869	594	0.68
10	0.00	2.058	594	0.54

OBSERVED DATA

15 Streamlined Blades, Radial
Dec. 1, 1934 Wet Bulb-56.5 Dry Bulb-81 Baro.-29.03

Reading Number	Orifice Diameter	Manometer Reading	Speed	Power Input
Units	Inches	"Alcohol	R.P.M.	K.W.
1	Open	0.004	563	2.12
2	17.24	0.487	566	1.95
3	16.25	0.751	572	1.84
4	15.25	1.016	574	1.70
5	13.99	1.332	579	1.52
6	12.50	1.641	582	1.34
7	11.50	1.816	584	1.21
8	10.18	1.936	586	1.08
9	7.25	2.129	589	0.83
10	0.00	2.306	594	0.65

15 Streamlined Blades, 10 Degree Back Angle
Dec. 1, 1934 Wet Bulb-56 Dry Bulb-80 Baro.-29.03

1	Open	0.007	570	1.83
2	17.24	0.476	571	1.75
3	16.25	0.734	573	1.66
4	15.25	0.986	576	1.57
5	13.99	1.276	578	1.46
6	12.50	1.575	579	1.28
7	11.50	1.731	582	1.19
9	7.25	2.074	590	0.82
10	0.00	2.183	591	0.62

15 Streamlined Blades, 15 Degree Back Angle
Dec. 1, 1934 Wet Bulb-56 Dry Bulb-81 Baro.-29.03

1	Open	0.007	573	1.68
2	17.24	0.454	575	1.61
3	16.25	0.712	576	1.55
4	15.25	0.962	577	1.48
5	13.99	1.243	580	1.35
6	12.50	1.528	582	1.22
7	11.50	1.691	585	1.12
9	7.25	2.022	589	0.77
10	0.00	2.113	593	0.58

OBSERVED DATA

15 Streamlined Blades, 20 Degree Back Angle
Dec. 5, 1934 Wet Bulb-53.5 Dry Bulb-88 Baro.-29.3

Reading Number	Orifice Diameter	Manometer Reading	Speed	Power Input
Units	Inches	"Alcohol	R.P.M.	K.W.
1	Open	0.004	571	1.62
2	17.24	0.438	574	1.55
3	16.25	0.690	575	1.50
4	15.25	0.936	577	1.40
5	13.99	1.218	578	1.30
6	12.50	1.598	581	1.19
7	11.50	1.679	584	1.11
8	10.18	1.834	587	1.00
9	7.25	2.003	590	0.75
10	0.00	2.082	593	0.57

15 Streamlined Blades, 25 Degree Back Angle
Dec. 5, 1934 Wet Bulb-56 Dry Bulb-82 Baro.-29.3

1	Open	0.004	576	1.45
2	17.24	0.418	577	1.40
3	16.25	0.658	578	1.37
4	15.25	0.898	580	1.32
5	13.99	1.177	580	1.26
6	12.50	1.448	583	1.16
7	11.50	1.615	584	1.07
8	10.18	1.776	585	0.98
9	7.25	1.934	590	0.75
10	0.00	2.017	593	0.58

15 Streamlined Blades, 30 Degree Back Angle
Dec. 6, 1934 Wet Bulb-53 Dry Bulb-76 Baro.-29.18

1	Open	0.004	577	1.41
2	17.24	0.404	580	1.335
3	16.25	0.624	581	1.27
4	15.25	0.852	582	1.23
5	13.99	1.133	582	1.17
6	12.50	1.419	583	1.10
7	11.50	1.581	585	1.02
8	10.18	1.740	587	0.91
9	7.25	1.892	588	0.69
10	0.00	1.973	592	0.53

OBSERVED DATA

30 Streamlined Blades, Radial

Jan. 8, 1935 Wet Bulb-67.5 Dry Bulb-84 Baro.-28.74

Reading Number	Orifice Diameter	Manometer Reading	Speed	Power Input
Units	Inches	"Alcohol	R.P.M.	K.W.
4	15.25	0.998	565	1.58
5	13.99	1.292	567	1.41
6	12.50	1.570	576	1.24
7	11.50	1.693	576	1.10
8	10.18	1.852	581	0.93
9	7.25	2.066	585	0.69
10	0.00	2.276	588	0.57

30 Streamlined Blades, 10 Degree Back Angle

Jan. 8, 1935 Wet Bulb-67.5 Dry Bulb-84 Baro.-28.74

1	Open	0.006	569	1.76
3	16.25	0.725	572	1.52
4	15.25	1.001	574	1.46
5	13.99	1.285	578	1.34
6	12.50	1.569	581	1.17
7	11.50	1.699	583	1.04
8	10.18	1.841	586	0.93
9	7.25	2.058	588	0.69
10	0.00	2.242	590	0.55

30 Streamlined Blades, 15 Degree Back Angle

Jan. 8, 1935 Wet Bulb-68 Dry Bulb-85 Baro.-28.74

1	Open	0.007	577	1.63
3	16.25	0.719	581	1.46
4	15.25	0.978	583	1.39
5	13.99	1.279	586	1.28
6	12.50	1.559	588	1.16
7	11.50	1.704	590	1.05
8	10.18	1.860	592	0.92
9	7.25	2.037	594	0.69
10	0.00	2.237	598	0.54

OBSERVED DATA

30 Streamlined Blades, 20 Degree Back Angle
Jan. 15,1935 Wet Bulb-64.5 Dry Bulb-85 Baro.-28.92

Reading Number	Orifice Diameter	Manometer Reading	Speed	Power Input
Units	Inches	"Alcohol	R.P.M.	K.W.
4	15.25	0.908	578	1.24
5	13.99	1.205	579	1.20
6	12.50	1.508	581	1.11
7	11.50	1.648	582	1.01
8	10.18	1.778	583	0.89
9	7.25	1.950	585	0.67
10	0.00	2.120	590	0.56

30 Streamlined Blades, 25 Degree Back Angle
Jan. 15, 1935 Wet Bulb-64.5 Dry Bulb-85 Baro.-28.92

1	Open	0.011	576	1.35
4	15.25	0.882	581	1.18
5	13.99	1.159	583	1.12
6	12.50	1.464	584	1.05
7	11.50	1.617	585	0.97
8	10.18	1.785	585	0.88
9	7.25	1.874	587	0.63
10	0.00	2.022	588	0.50

30 Streamlined Blades, 30 Degree Back Angle
Jan. 15, 1935 Wet Bulb-65 Dry Bulb-85.5 Baro.-28.92

1	Open	0.012	580	1.28
4	15.25	0.813	582	1.10
5	13.99	1.099	585	1.06
6	12.50	1.372	587	0.97
7	11.50	1.579	587	0.92
8	10.18	1.713	589	0.83
9	7.25	1.864	593	0.63
10	0.00	2.066	596	0.51

OBSERVED DATA

6 Straight Blades, Radial
Mar. 22, 1935 Wet Bulb-65 Dry Bulb-92 Baro.-29.10

Reading Number	Orifice Diameter	Manometer Reading	Speed	Power Input
Units	Inches	"Alcohol	R.P.M.	K.W.÷.4
5	13.99	1.222	581	3.36
6	12.50	1.548	583	3.03
7	11.50	1.721	586	2.74
8	10.18	1.824	588	2.40

6 Straight Blades, 10 Degree Back Angle
Mar. 22, 1935 Wet Bulb-65 Dry Bulb-92.5 Baro.-29.10

5	13.99	1.182	581	3.27
6	12.50	1.502	583	3.00
7	11.50	1.665	585	2.72
8	10.18	1.777	588	2.37

6 Straight Blades, 15 Degree Back Angle
Mar. 22, 1935 Wet Bulb-65.5 Dry Bulb-93 Baro.-29.10

5	13.99	1.156	581	3.18
6	12.50	1.458	585	2.88
7	11.50	1.615	585	2.62
8	10.18	1.720	588	2.30

6 Straight Blades, 20 Degree Back Angle
Mar. 22, 1935 Wet Bulb-66 Dry Bulb-93 Baro.-29.10

5	13.99	1.115	583	3.09
6	12.50	1.406	584	2.87
7	11.50	1.564	586	2.56
8	10.18	1.679	588	2.21

6 Straight Blades, 25 Degree Back Angle
Mar. 22, 1935 Wet Bulb-65.5 Dry Bulb-93 Baro.-29.10

5	13.99	1.088	584	2.95
6	12.50	1.368	585	2.67
7	11.50	1.521	587	2.48
8	10.18	1.633	589	2.18

6 Straight Blades, 30 Degree Back Angle
Mar. 22, 1935 Wet Bulb-65 Dry Bulb-92 Baro.-29.10

5	13.99	1.049	584	2.89
6	12.50	1.314	586	2.61
7	11.50	1.462	588	2.39
8	10.18	1.585	589	2.08

OBSERVED DATA

10 Straight Blades, Radial
Mar. 30, 1935 Wet Bulb-69 Dry Bulb-87 Baro.-28.92

Reading Number	Orifice Diameter	Manometer Reading	Speed	Power Input
Units	Inches	"Alcohol	R.P.M.	K.W.÷.4
5	13.99	1.347	577	3.71
6	12.50	1.695	580	3.32
7	11.50	1.837	582	3.01
8	10.18	1.962	586	2.63

10 Straight Blades, 10 Degree Back Angle
Mar. 30, 1935 Wet Bulb-67.5 Dry Bulb-87 Baro.-28.92

5	13.99	1.315	579	3.50
6	12.50	1.641	582	3.15
7	11.50	1.796	585	2.85
8	10.18	1.922	587	2.52

10 Straight Blades, 15 Degree Back Angle
Mar. 30, 1935 Wet Bulb-68 Dry Bulb-87 Baro.-28.92

5	13.99	1.276	582	3.38
6	12.50	1.597	584	3.07
7	11.50	1.759	586	2.81
8	10.18	1.873	588	2.42

10 Straight Blades, 20 Degree Back Angle
Mar. 30, 1935 Wet Bulb-68 Dry Bulb-87 Baro.-28.92

5	13.99	1.242	582	3.27
6	12.50	1.560	584	3.03
7	11.50	1.702	586	2.70
8	10.18	1.830	588	2.38

10 Straight Blades, 25 Degree Back Angle
Mar. 30, 1935 Wet Bulb-69.5 Dry Bulb-84 Baro.-28.92

5	13.99	1.197	581	3.22
6	12.50	1.509	583	2.96
7	11.50	1.671	586	2.67
8	10.18	1.788	588	2.35

10 Straight Blades, 30 Degree Back Angle
Mar. 30, 1935 Wet Bulb-69.5 Dry Bulb-84 Baro.-28.92

5	13.99	1.150	584	3.13
6	12.50	1.446	585	2.84
7	11.50	1.597	587	2.62
8	10.18	1.700	588	2.33

OBSERVED DATA

15 Straight Blades, Radial
Apr. 3, 1935 Wet Bulb-67.5 Dry Bulb-88 Baro.-28.88

Reading Number	Orifice Diameter	Manometer Reading	Speed	Power Input
Units	Inches	"Alcohol	R.P.M.	K.W.÷.4
5	13.99	1.340	578	3.70
6	12.50	1.659	582	3.25
7	11.50	1.888	582	2.93
8	10.18	1.959	586	2.57

15 Straight Blades, 10 Degree Back Angle
Apr. 3, 1935 Wet Bulb-67.5 Dry Bulb-88 Baro.-28.88

5	13.99	1.300	578	3.52
6	12.50	1.604	582	3.08
7	11.50	1.786	584	2.80
8	10.18	1.917	586	2.47
9	7.25	2.038	590	1.70
10	0.00	2.123	594	1.35

15 Straight Blades, 20 Degree Back Angle
Apr. 3, 1935 Wet Bulb-66 Dry Bulb-87 Baro.-28.88

5	13.99	1.246	582	3.25
6	12.50	1.539	584	2.90
7	11.50	1.713	586	2.67
8	10.18	1.859	587	2.38

15 Straight Blades, 30 Degree Back Angle
Apr. 3, 1935 Wet Bulb-66 Dry Bulb-87 Baro.-28.88

5	13.99	1.165	583	3.00
6	12.50	1.458	586	2.75
7	11.50	1.632	586	2.53
8	10.18	1.766	589	2.22

OBSERVED DATA

30 Straight Blades, Radial

April 5, 1935 Wet Bulb-68 Dry Bulb-85 Baro.-28.72

Reading Number	Orifice Diameter	Manometer Reading	Speed	Power Input
Units	Inches	"Alcohol	R.P.M.	K.W.÷.4
5	13.99	1.366	578	3.75
6	12.50	1.678	581	3.40
7	11.50	1.833	584	2.93
8	10.18	1.949	587	2.55

30 Straight Blades, 10 Degree Back Angle

April 5, 1935 Wet Bulb-68.5 Dry Bulb-87 Baro.-28.72

5	13.99	1.366	578	3.75
6	12.50	1.613	583	3.20
7	11.50	1.754	585	2.91
8	10.18	1.884	588	2.57

30 Straight Blades, 15 Degree Back Angle

April 5, 1935 Wet Bulb-68 Dry Bulb-86 Baro.-28.72

5	13.99	1.282	580	3.55
6	12.50	1.584	584	3.13
7	11.50	1.729	585	2.91
8	10.18	1.889	586	2.47

30 Straight Blades, 20 Degree Back Angle

April 5, 1935 Wet Bulb-67.5 Dry Bulb-85.5 Baro.-28.72

5	13.99	1.253	582	3.46
6	12.50	1.551	584	3.02
7	11.50	1.722	586	2.77
8	10.18	1.854	587	2.49

30 Straight Blades, 25 Degree Back Angle

April 5, 1935 Wet Bulb-67 Dry Bulb-85 Baro.-28.72

5	13.99	1.218	582	3.20
6	12.50	1.511	585	2.96
7	11.50	1.669	586	2.67
8	10.18	1.808	587	2.39

Calculations of Results - Formulae Used

To determine the flow of air, the general flow formula for air through a thin plate orifice when the pressure drop is less than one percent was used.

$Q = 1096.5 \times A_2 \times C_f \times C_v \times \sqrt{\frac{P}{w}}$

Q = cu. ft. per minute of air

A_1 = area of duct in sq. ft.

A_2 = Area of orifice in sq. ft.

C_f = coefficient of discharge

C_v = velocity of approach factor = $\frac{1}{\sqrt{1 - \left(\frac{A_1}{A_2}\right)^2}}$

P = pressure drop across the orifice, or static pressure before the orifice in inches of water.

w = actual density of the air before the orifice.

After investigating the results of coefficient determinations for air measuring instruments similiar to the one used it was decided that a value of .608 for the coefficient of discharge was the most accurate for this set up.

The following tabulation of coefficients give a comparison of the product of C_f and C_v as used and those determined by accurate calibrations of orifices. The coefficients shown are equivalent to the product of C_f and C_v but were actually determined as one coefficient.

Coefficient of Discharge x Velocity

of Approach Factor

Area Ratio of Orifice to Duct	$C_f \times C_v$ Values Used	$C_f \times C_v$ Stach	$C_f \times C_v$ Spitzglass
.1503	.615	.610	.613
.296	.637	.635	.637
.378	.660	.658	.657
.447	.685	.681	.680
.560	.735	.730	.730
.665	.813	.794	.805
.755	.935		
.850	1.150		

The values as determined by Stach appear in A.S.M.E. Transactions, Vol. 57:429, 1935. They are for air flowing through a thin plate discharge orifice in a 10 inch duct using flange static pressure taps. His determinations were accurate to ±0.8%.

The values as determined by Spitzglass appear in A.S.M.E. Transactions, Vol. 44:947, 1922. They are for pipe taps, the up stream tap located at from .75 diameters to 2.0 diameters and the downstream tap at the vena contracta.

Data for area ratios of greater than .70% was not available. The reason for this is set forth by Spitzglass in his discussion in the above mentioned article. Very small errors in the measurement of the

(6) Static pressure, actual

= inches of alcohol x specific gr. of alcohol

= 1.816 x .803 = 1.46 inches of water.

The specific gravity of the ethyl alcohol used was determined at 60 deg. F. with a hydrometer and a temperature-specific gravity curve for the alcohol plotted, using values from Smithsonian Physical Tables. The specific gravity at the existing temperature was used.

(7) Static pressure corrected to constant speed

= S.P. actual x square of ratio of speed

$= 1.46 \times \left(\frac{600}{584}\right)^2 = 1.54$ in. of water.

(8) Static pressure corrected to std. air density

= S.P. at const. speed x ratio of densities

$= 1.54 \times \frac{.07495}{.0708} = 1.63$ in. of water.

(9) Static pressure corrected to fan outlet

= S.P. corr. to std. den. + corr. friction loss

$= 1.63 + .0257 \times \frac{L}{D} \times$ corrected vel. press.

$= 1.63 + .0257 \times \frac{14 \times 12}{18.7} \times .101$

= 1.655 in. of water

(10) Capacity, cu.ft. per min.

$= 1096.5 \times A_2 \times C_f \times C_v\sqrt{\frac{P}{w}}$

$= 1096.5 \times \frac{103.87}{144} \times .608 \times 1.08\sqrt{\frac{1.46}{.0708}}$

= 2375 cu.ft. per min.

(11) Capacity corrected to constant speed

= cap., actual x ratio of speed

$= 2375 \times \frac{600}{584} = 2440$ cu.ft. per min.

(12) Velocity pressure corr. for speed and density

$$= \left(\frac{\text{vel.-ft. per min. corr.}}{1096.5}\right)^2 \times \text{Std. density}$$

$$= \left(\frac{\text{cu. ft. per min.}}{1096.5 \times \text{area of duct}}\right)^2 \times .07495$$

$$= \left(\frac{.07495 \times 2440}{1096.5 \times 275.6 \div 144}\right)^2$$

$$= (.0001303 \times 2440)^2$$

$$= 0.101 \text{ in. of water}$$

(13) Total pressure, corrected

= static press.,corr. + vel. press.,corr.

= 1.655 + .101 = 1.756 in. of water

(14) Air horsepower, corrected

= .000157 x total press. x cu.ft.air/min.

= .000157 x 1.756 x 2440

= .672 hp.

(15) Mechanical efficiency

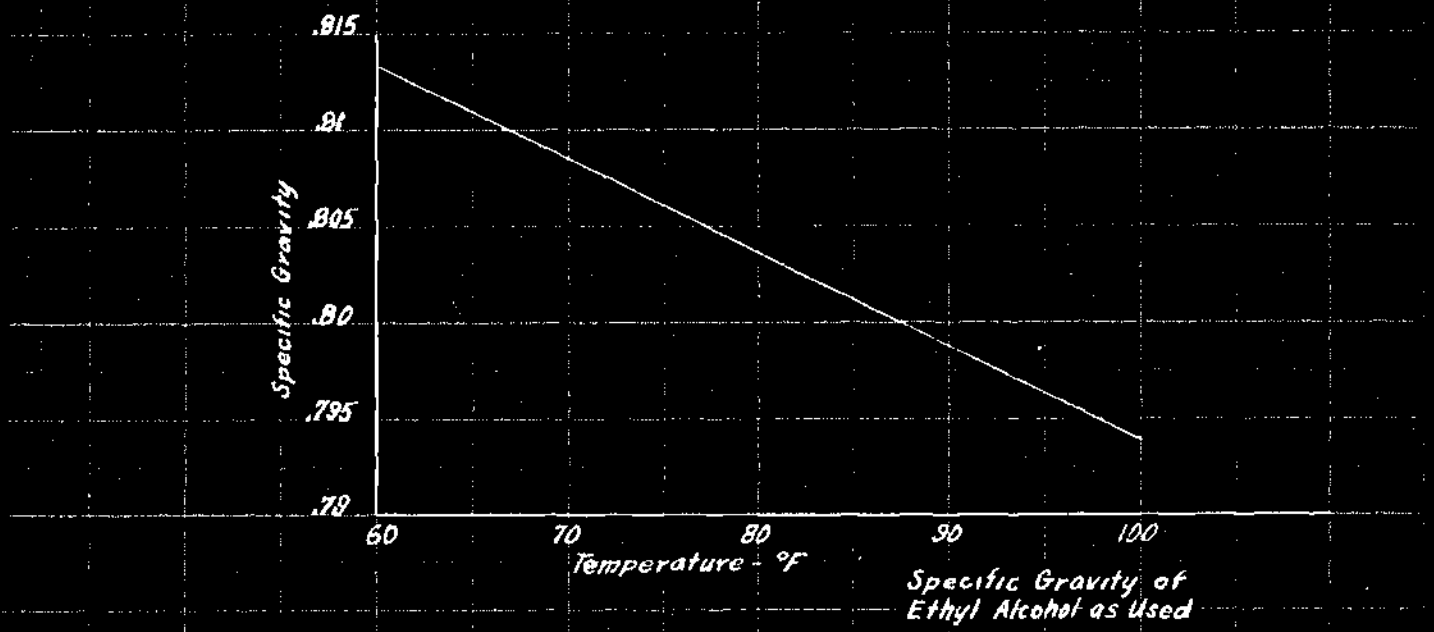
= air hp. ÷ hp. input

= 0.672 ÷ 1.383

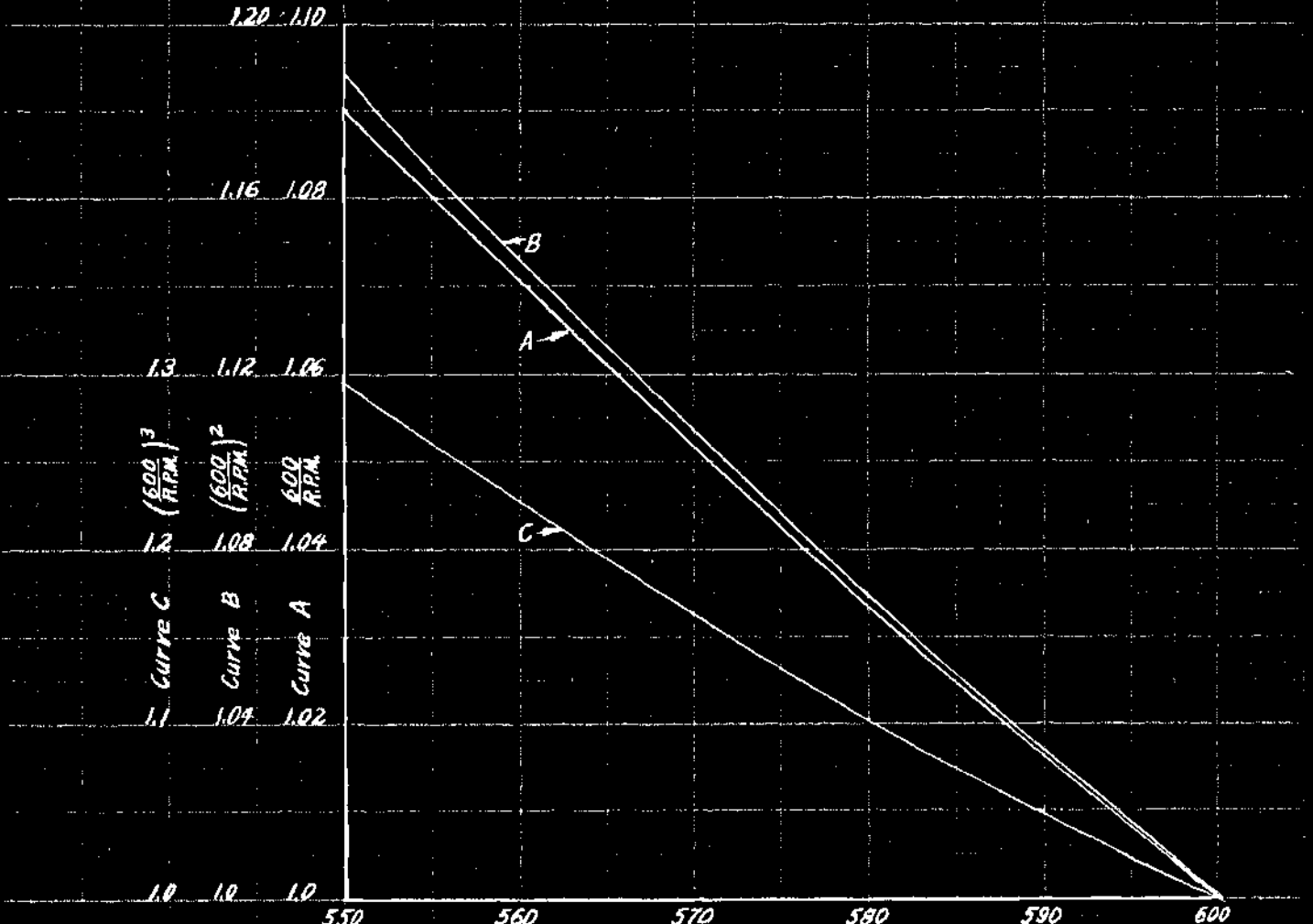
= .486 or 48.6%

Results

The results of calculations for all readings are tabulated. The mechanical efficiency was determined from each set of readings. Due to inherent errors in taking data their values could not be accepted as representative. For each run horsepower and total pressure curves were plotted against capacity. The efficiency curve was then plotted by using efficiencies determined from capacity, pressure, and horsepower readings off the curves.



Specific Gravity of Ethyl Alcohol as Used



Curves for Speed Corrections

TABULATED RESULTS

6 Streamlined Blades, 10 Degree Back Angle

Read. No.	Speed	Power Input to Fan			Static Pressure		
		Actual	Const. Speed	Std. Air	Actual	Const. Speed	Std. Air
Units	R.P.M.	Horsepower			Inches of Water		
1	577	1.45	1.62	1.725	0.000	0.000	0.000
2	577	1.41	1.58	1.68	0.305	0.33	0.356
3	577	1.39	1.555	1.655	0.49	0.53	0.569
4	578	1.36	1.52	1.62	0.687	0.741	0.793
5	580	1.28	1.414	1.505	0.923	0.988	1.055
6	581	1.16	1.273	1.355	1.17	1.25	1.332
7	582	1.06	1.16	1.235	1.29	1.37	1.460
8	583	0.89	0.978	1.04	1.39	1.47	1.567
9	587	0.635	0.677	0.721	1.53	1.60	1.706
10	589	0.51	0.538	0.573	1.70	1.76	1.87

Read. No.	S.P.Fan Outlet	Capacity Actual	Capacity Corr.	Vel.P. Corr.	T.P. Corr.	Air Hp Corr.	Mech. Eff.
Units	"water	C.F.M.		"water		H.P.	%
2	0.432	4250	4420	.331	0.763	.529	31.5
3	0.632	3860	4010	.272	0.904	.569	34.4
4	0.845	3530	3660	.227	1.072	.613	37.8
5	1.095	3090	3200	.173	1.268	.637	43.3
6	1.361	2610	2700	.124	1.485	.630	46.5
7	1.481	2240	2310	.091	1.572	.570	46.2
8	1.58	1755	1805	.055	1.635	.455	44.6
9	1.71	895	914	.016	1.726	.247	34.3
10	1.87	000	000	000	1.87	000	00.0

TABULATED RESULTS

6 Streamlined Blades, 15 Degree Back Angle

Read. No.	Speed	Power Input to Fan			Static Pressure		
		Actual	Const. Speed	Std. Air	Actual	Const. Speed	Std. Air
Units	R.P.M.	Horsepower			Inches of Water		
1	576	1.40	1.575	1.652	0.000	0.000	0.000
2	577	1.36	1.523	1.60	0.301	0.325	0.344
3	577	1.34	1.50	1.575	0.486	0.525	0.554
4	578	1.32	1.471	1.544	0.683	0.737	0.776
5	579	1.26	1.40	1.47	0.918	0.986	1.036
6	581	1.14	1.261	1.313	1.156	1.233	1.295
7	583	1.03	1.12	1.175	1.285	1.36	1.429
8	586	0.88	0.941	0.987	1.378	1.445	1.518
9	589	0.62	0.654	0.686	1.53	1.588	1.667
10	590	0.54	0.566	0.593	1.82	1.87	1.96

Read. No.	S.P.Fan Outlet	Capacity Actual	Capacity Corr.	Vel.P. Corr.	T.P. Corr.	Air Hp Corr.	Mech. Eff.
Units	"water	C.F.M.		"water		H.P.	%
2	0.418	4180	4350	.32	0.738	.504	31.5
3	0.616	3810	3960	.267	0.883	.548	34.8
4	0.827	3490	3620	.232	1.049	.596	38.6
5	1.075	3060	3170	.171	1.246	.620	42.2
6	1.323	2575	2660	.120	1.453	.607	46.2
7	1.449	2215	2280	.088	1.537	.550	46.8
8	1.53	1733	1775	.053	1.583	.451	44.7
9	1.67	888	905	.014	1.684	.239	34.9
10	1.96	000	000	000	1.96	000	00.0

TABULATED RESULTS

6 Streamlined Blades, 20 Degree Back Angle

Read. No.	Speed	Power Input to Fan: Actual	Const. Speed	Std. Air	Static Pressure: Actual	Const. Speed	Std. Air
Units	R.P.M.	Horsepower			Inches of Water		
1	576	1.29	1.45	1.54	0.000	0.000	0.000
2	576	1.26	1.42	1.51	0.285	0.31	0.335
3	577	1.26	1.41	1.50	0.458	0.495	0.531
4	578	1.24	1.38	1.47	0.643	0.694	0.742
5	578	1.17	1.305	1.39	0.867	0.935	0.997
6	581	1.06	1.16	1.235	1.093	1.165	1.244
7	581	0.95	1.04	1.11	1.22	1.30	1.385
8	583	0.81	0.88	0.937	1.32	1.40	1.493
9	583	0.58	0.63	0.67	1.467	1.55	1.652
10	589	0.53	0.56	0.596	1.8	1.87	1.99

Read. No.	S.P.Fan Outlet	Capacity: Actual	Corr.	Vel.P.: Corr.	T.P. Corr.	Air Hp: Corr.	Mech. Eff.
Units	"water	C.F.M.		"water		H.P.	%
2	0.407	4110	4280	.31	0.717	.482	31.9
3	0.590	3730	3880	.255	.845	.516	34.4
4	0.791	3410	3540	.212	1.003	.557	37.9
5	1.035	3000	3110	.164	1.199	.585	42.1
6	1.273	2630	2720	.125	1.398	.597	48.3
7	1.405	2170	2240	.085	1.490	.524	47.2
8	1.505	1710	1760	.052	1.557	.429	45.8
9	1.655	875	900	.014	1.669	.236	35.2
10	1.99	000	000	000	1.99	000	00.0

TABULATED RESULTS

6 Streamlined Blades, 25 Degree Back Angle

Read. No.	Speed	Power Input to Fan			Static Pressure		
		Actual	Const. Speed	Std. Air	Actual	Const. Speed	Std. Air
Units	R.P.M.	Horsepower			Inches of Water		
1	579	1.26	1.40	1.465	0.000	0.000	0.000
2	579	1.24	1.38	1.444	0.281	0.302	0.319
3	579	1.23	1.37	1.432	0.45	0.483	0.508
4	581	1.21	1.33	1.39	0.635	0.677	0.711
5	582	1.16	1.27	1.33	0.86	0.914	0.958
6	583	1.04	1.13	1.18	1.085	1.15	1.205
7	586	0.96	1.03	1.08	1.205	1.265	1.324
8	589	0.81	0.855	0.895	1.305	1.355	1.419
9	590	0.63	0.611	0.692	1.455	1.50	1.570
10	591	0.59	0.617	0.645	1.83	1.885	1.995

Read. No.	S.P.Fan Outlet	Capacity		Vel.P. Corr.	T.P. Corr.	Air Hp Corr.	Mech. Eff.
		Actual	Corr.				
Units	"water	C.F.M.		"water		H.P.	%
2	0.387	4040	4180	.296	0.683	.442	31.1
3	0.565	3670	3800	.245	0.810	.477	33.7
4	0.758	3370	3480	.205	0.963	.522	37.5
5	0.994	2960	3050	.157	1.151	.552	41.5
6	1.231	2490	2560	.111	1.342	.539	45.7
7	1.343	2145	2195	.082	1.425	.491	45.5
8	1.431	1685	1715	.050	1.481	.399	44.6
9	1.573	865	880	.013	1.586	.219	31.7
10	1.97	000	000	000	1.97	000	00.0

TABULATED RESULTS

6 Streamlined Baldes, 20 Degree Forward Angle

Read. No.	Speed	Power Input to Fan			Static Pressure		
		Actual	Const. Speed	Std. Air	Actual	Const. Speed	Std. Air
Units	R.P.M.	Horsepower			Inches of Water		
1	566	1.73	2.06	2.195	0.000	0.000	0.000
2	568	1.63	1.92	2.05	0.321	0.358	0.387
3	572	1.58	1.82	1.94	0.514	0.565	0.607
4	574	1.52	1.73	1.84	0.715	0.781	0.836
5	576	1.42	1.60	1.70	0.963	1.044	1.115
6	578	1.28	1.43	1.52	1.22	1.315	1.403
7	579	1.16	1.29	1.37	1.36	1.46	1.558
8	585	1.00	1.075	1.145	1.44	1.515	1.616
9	591	0.69	0.72	0.767	1.55	1.60	1.707
10	592	0.56	0.58	0.618	1.69	1.736	1.85

Read. No.	S.P.Fan Outlet	Capacity Actual	Capacity Corr.	Vel.P. Corr.	T.P. Corr.	Air Hp Corr.	Mech. Eff.
Units	"water	C.F.M.		"water		H.P.	%
2	0.469	4350	4590	.356	0.825	.595	29.0
3	0.674	3950	4150	.291	0.965	.622	32.4
4	0.891	3600	3760	.239	1.130	.660	36.3
5	1.157	3160	3290	.183	1.340	.692	40.7
6	1.433	2660	2760	.129	1.562	.678	44.6
7	1.580	2290	2370	.095	1.675	.625	45.6
8	1.629	1785	1830	.057	1.686	.484	42.3
9	1.71	900	914	.014	1.724	.247	32.2
10	1.85	000	000	000	1.85	000	00.0

TABULATED RESULTS

10 Streamlined Blades, Radial

Read. No.	Speed	Power Input to Fan: Actual	Power Input to Fan: Const. Speed	Power Input to Fan: Std. Air	Static Pressure: Actual	Static Pressure: Const. Speed	Static Pressure: Std. Air
Units	R.P.M.	Horsepower	Horsepower	Horsepower	Inches of Water	Inches of Water	Inches of Water
1	563	2.09	2.53	2.605	0.000	0.000	0.000
2	567	1.95	2.305	2.37	0.387	0.433	0.449
3	569	1.85	2.165	2.227	0.606	0.672	0.694
4	572	1.74	2.00	2.055	0.83	0.913	0.941
5	575	1.605	1.817	1.87	1.096	1.193	1.23
6	579	1.43	1.59	1.635	1.36	1.463	1.508
7	581	1.29	1.416	1.457	1.492	1.59	1.638
8	583	1.13	1.23	1.265	1.615	1.71	1.759
9	588	0.79	0.837	0.861	1.745	1.815	1.867
10	591	0.59	0.617	0.635	1.885	1.94	1.995

Read. No.	S.P.Fan Outlet	Capacity Actual	Capacity Corr.	Vel.: Corr.	T.P. Corr.	Air Hp: Corr.	Mech.: Eff.
Units	"water	C.F.M.	C.F.M.	"water	"water	H.P.	%
2	0.556	4700	4970	.420	0.976	.761	32.1
3	0.771	4210	4430	.334	1.105	.770	34.5
4	1.004	3810	4000	.272	1.276	.800	39.0
5	1.277	3310	3450	.202	1.479	.800	42.8
6	1.540	2760	2860	.139	1.679	.754	46.1
7	1.661	2360	2435	.101	1.762	.673	46.2
8	1.773	1860	1910	.062	1.835	.551	43.5
9	1.871	940	960	.016	1.887	.285	33.1
10	1.995	000	000	000	1.995	000	00.0

TABULATED RESULTS

10 Streamlined Blades, 10 Degree Back Angle

Read. No.	Speed	Power Input to Fan			Static Pressure		
		Actual	Const. Speed	Std. Air	Actual	Const. Speed	Std. Air
Units	R.P.M.	Horsepower			Inches of Water		
1	566	1.825	2.17	2.227	0.000	0.000	0.000
2	568	1.79	2.105	2.16	0.372	0.414	0.428
3	569	1.70	1.99	2.045	0.581	0.645	0.664
4	572	1.59	1.83	1.88	0.786	0.865	0.889
5	575	1.50	1.70	1.745	1.048	1.14	1.172
6	578	1.32	1.472	1.51	1.315	1.416	1.454
7	580	1.26	1.393	1.43	1.44	1.54	1.581
8	582	1.12	1.219	1.25	1.555	1.65	1.695
9	587	0.77	0.82	0.841	1.665	1.74	1.787
10	590	0.57	0.598	0.614	1.815	1.87	1.92

Read. No.	S.P.Fan Outlet	Capacity Actual	Capacity Corr.	Vel.P. Corr.	T.P. Corr.	Air Hp Corr.	Mech. Eff.
Units	"water	C.F.M.		"water		H.P.	%
2	0.521	4610	4860	.401	0.922	.702	32.5
3	0.738	4130	4350	.321	1.059	.724	35.4
4	0.948	3710	3890	.257	1.205	.767	39.2
5	1.217	3240	3380	.194	1.411	.748	42.9
6	1.485	2720	2820	.135	1.620	.717	47.5
7	1.604	2320	2400	.098	1.702	.640	44.8
8	1.709	1825	1880	.060	1.769	.523	41.8
9	1.79	920	940	.015	1.805	.267	31.7
10	1.92	000	000	000	1.92	000	00.0

TABULATED RESULTS

10 Streamlined Blades, 15 Degree Back Angle

Read. No.	Speed	Power Input to Fan			Static Pressure		
		Actual	Const. Speed	Std. Air	Actual	Const. Speed	Std. Air
Units	R.P.M.	Horsepower			Inches of Water		
1	570	1.68	1.96	2.035	0.000	0.000	0.000
2	572	1.64	1.885	1.96	0.359	0.395	0.414
3	574	1.56	1.78	1.85	0.557	0.608	0.637
4	576	1.49	1.68	1.745	0.761	0.826	0.860
5	578	1.37	1.53	1.59	0.99	1.067	1.109
6	580	1.25	1.38	1.434	1.26	1.35	1.404
7	583	1.10	1.197	1.243	1.37	1.45	1.509
8	584	0.97	1.047	1.088	1.49	1.573	1.635
9	585	0.65	0.70	0.727	1.606	1.688	1.756
10	584	0.46	1.495	0.514	1.69	1.78	1.85

Read. No.	S.P.Fan Outlet	Capacity Actual	Capacity Corr.	Vel.P. Corr.	T.P. Corr.	Air Hp Corr.	Mech. Eff.
Units	"water	C.F.M.		"water		H.P.	%
2	0.503	4550	4770	.385	0.888	.665	33.9
3	0.705	4060	4250	.305	1.010	.673	36.4
4	0.917	3670	3820	.247	1.164	.698	40.0
5	1.151	3160	3280	.182	1.333	.685	43.1
6	1.434	2680	2770	.130	1.564	.681	47.5
7	1.530	2280	2345	.093	1.623	.598	48.1
8	1.648	1795	1840	.057	1.705	.493	45.3
9	1.759	910	931	.015	1.774	.259	35.7
10	1.85	000	000	000	1.85	000	00.0

TABULATED RESULTS

10 Streamlined Blades, 20 Degree Back Angle

Read. No.	Speed	Power Input to Fan			Static Pressure		
		Actual	Const. Speed	Std. Air	Actual	Const. Speed	Std. Air
Units	R.P.M.	Horsepower			Inches of Water		
1	567	1.55	1.84	1.91	0.000	0.000	0.000
2	568	1.47	1.73	1.80	0.331	0.368	0.386
3	570	1.39	1.615	1.68	0.512	0.567	0.592
4	572	1.30	1.494	1.55	0.708	0.779	0.812
5	573	1.22	1.40	1.45	0.943	1.033	1.076
6	574	1.16	1.32	1.37	1.186	1.295	1.340
7	576	1.04	1.17	1.215	1.32	1.432	1.489
8	579	0.90	1.00	1.14	1.405	1.51	1.570
9	581	0.65	0.713	0.74	1.511	1.61	1.674
10	584	0.46	0.497	0.516	1.64	1.73	1.798

Read. No.	S.P.Fan Outlet	Capacity Actual	Capacity Corr.	Vel.P. Corr.	T.P. Corr.	Air Hp Corr.	Mech. Eff.
Units	"water	C.F.M.		"water		H.P.	%
2	0.469	4370	4610	.360	0.829	.600	33.3
3	0.657	3890	4090	.283	0.940	.605	36.0
4	0.866	3540	3710	.233	1.099	.640	41.3
5	1.117	3090	3240	.178	1.295	.660	45.5
6	1.377	2600	2720	.125	1.502	.643	46.9
7	1.510	2235	2327	.092	1.602	.585	48.2
8	1.583	1743	1810	.055	1.638	.547	40.8
9	1.678	880	910	.014	1.692	.442	32.7
10	1.798	000	000	000	1.798	000	00.0

TABULATED RESULTS

10 Streamlined Blades, 25 Degree Back Angle

Read. No.	Speed	Power Input to Fan			Static Pressure		
		Actual	Const. Speed	Std. Air	Actual	Const. Speed	Std. Air
Units	R.P.M.	Horsepower			Inches of Water		
1	566	1.42	1.69	1.755	0.000	0.000	0.000
2	569	1.36	1.59	1.65	0.318	0.353	0.37
3	573	1.35	1.546	1.606	0.499	0.548	0.572
4	574	1.35	1.54	1.6	0.7.3	0.78	0.812
5	576	1.26	1.42	1.475	0.93	1.01	1.051
6	578	1.14	1.272	1.322	1.157	1.248	1.297
7	579	1.00	1.11	1.153	1.283	1.38	1.434
8	583	0.87	0.947	0.984	1.395	1.476	1.533
9	589	0.62	0.655	1.68	1.54	1.6	1.662
10	590	0.45	0.472	0.49	1.66	1.713	1.78

Read. No.	S.P.Fan Outlet	Capacity Actual	Capacity Corr.	Vel.P. Corr.	T.P. Corr.	Air Hp Corr.	Mech. Eff.
Units	"water	C.F.M.		"water		H.P.	%
2	0.447	4280	4510	.345	0.792	.560	34.0
3	0.635	3840	4020	.274	0.909	.573	35.7
4	0.866	3555	3720	.234	1.100	.641	40.1
5	1.091	3060	3190	.172	1.263	.633	42.9
6	1.325	2567	2665	.120	1.445	.605	45.7
7	1.454	2205	2285	.088	1.542	.554	48.0
8	1.545	1735	1785	.054	1.599	.448	45.5
9	1.665	887	905	.014	1.679	.239	35.1
10	1.78	000	000	000	1.78	000	00.0

TABULATED RESULTS

10 Streamlined Blades, 30 Degree Back Angle

Read. No.	Speed	Power Input to Fan			Static Pressure		
		Actual	Const. Speed	Std. Air	Actual	Const. Speed	Std. Air
Units	R.P.M.	Horsepower			Inches of Water		
1	582	1.38	1.507	1.562	0.000	0.000	0.000
2	583	1.32	1.435	1.488	0.31	0.328	0.342
3	583	1.30	1.414	1.465	0.512	0.542	0.564
4	584	1.27	1.372	1.422	0.694	0.733	0.761
5	585	1.22	1.313	1.361	0.917	0.964	1.000
6	587	1.10	1.173	1.217	1.16	1.213	1.258
7	588	1.00	1.06	1.10	1.275	1.326	1.375
8	591	0.85	0.888	0.92	1.38	1.422	1.475
9	594	0.60	0.618	0.641	1.511	1.541	1.597
10	594	0.44	0.453	0.47	1.665	1.698	1.75

Read. No.	S.P.Fan Outlet	Capacity Actual	Capacity Corr.	Vel.P. Corr.	T.P. Corr.	Air Hp Corr.	Mech. Eff.
Units	"water	C.F.M.		"water		H.P.	%
2	0.416	4220	4340	.320	0.736	.488	32.8
3	0.627	3885	4000	.271	0.898	.564	38.5
4	0.811	3500	3590	.218	1.029	.580	40.8
5	1.038	3040	3120	.165	1.203	.590	43.3
6	1.285	2565	2620	.116	1.401	.575	47.3
7	1.395	2190	2235	.085	1.480	.520	47.2
8	1.487	1723	1750	.052	1.539	.423	45.9
9	1.600	870	873	.013	1.613	.222	34.7
10	1.76	000	000	000	1.760	000	00.0

TABULATED RESULTS

15 Streamlined Blades, Radial

Read. No.	Speed	Power Input to Fan			Static Pressure		
		Actual	Const. Speed	Std. Air	Actual	Const. Speed	Std. Air
Units	R.P.M.	Horsepower			Inches of Water		
1	563	2.06	2.495	2.64	0.000	0.000	0.000
2	566	1.91	2.27	2.40	0.301	0.44	0.466
3	572	1.82	2.09	2.21	0.604	0.865	0.704
4	574	1.69	1.93	2.045	0.815	0.89	0.942
5	579	1.52	1.685	1.78	1.07	1.15	1.217
6	582	1.34	1.483	1.55	1.32	1.40	1.488
7	584	1.21	1.307	1.383	1.48	1.54	1.631
8	586	1.06	1.134	1.20	1.555	1.63	1.726
9	589	0.77	0.812	0.86	1.71	1.78	1.855
10	594	0.57	0.587	0.621	1.855	1.89	2.00

Read. No.	S.P.Fan Outlet	Capacity Actual	Capacity Corr.	Vel.P. Corr.	T.P. Corr.	Air Hp Corr.	Mech. Eff.
Units	"water	C.F.M.	C.F.M.	"water	"water	H.P.	%
2	0.572	4800	5080	.440	1.012	.807	38.6
3	0.766	4250	4460	.388	1.184	.787	35.6
4	1.009	3840	4010	.273	1.282	.807	39.4
5	1.268	3290	3410	.198	1.464	.783	43.7
6	1.517	2770	2850	.138	1.655	.741	47.8
7	1.668	2375	2440	.101	1.756	.672	48.8
8	1.74	1850	1890	.081	1.801	.534	44.5
9	1.89	944	961	.016	1.906	.287	33.4
10	2.0	000	000	000	2.00	000	00.0

TABULATED RESULTS

15 Streamlined Blades, 10 Degree Back Angle

Read. No.	Speed	Power Input to Fan			Static Pressure		
		Actual	Const. Speed	Std. Air	Actual	Const. Speed	Std. Air
Units	R.P.M.	Horsepower			Inches of Water		
1	570	1.81	2.105	2.22	0.000	0.000	0.000
2	571	1.73	2.000	2.11	0.382	0.422	0.451
3	573	1.65	1.89	1.995	0.59	0.647	0.688
4	576	1.57	1.77	1.87	0.792	0.86	1.912
5	578	1.46	1.63	1.72	1.025	1.105	1.169
6	579	1.28	1.42	1.50	1.265	1.36	1.439
7	582	1.18	1.29	1.36	1.39	1.475	1.558
9	590	0.76	0.797	0.841	1.67	1.72	1.817
10	591	0.53	0.554	0.585	1.755	1.81	1.91

Read. No.	S.P.Fan Outlet	Capacity Actual	Capacity Corr.	Vel.P. Corr.	T.P. Corr.	Air Hp Corr.	Mech. Eff.
Units	"water	C.F.M.		"water		H.P.	%
2	0.548	4730	4970	.42	0.968	.755	35.8
3	0.764	4210	4400	.329	1.093	.754	37.8
4	0.973	3780	3940	.263	1.236	.765	40.8
5	1.213	3250	3365	.192	1.405	.743	43.2
6	1.47	2705	2805	.134	1.604	.701	47.1
7	1.58	2315	2375	.096	1.676	.628	46.0
9	1.82	931	946	.015	1.835	.272	32.4
10	1.91	000	000	000	1.91	000	00.0

TABULATED RESULTS

15 Streamlined Blades, 15 Degree Back Angle

Read. No.	Speed	Power Input to Fan			Static Pressure		
		Actual	Const. Speed	Std. Air	Actual	Const. Speed	Std. Air
Units	R.P.M.	Horsepower			Inches of Water		
1	573	1.67	1.91	2.02	0.000	0.000	0.000
2	575	1.60	1.81	1.915	0.365	0.397	0.426
3	576	1.55	1.76	1.85	0.572	0.621	0.662
4	577	1.48	1.66	1.755	0.773	0.836	0.888
5	580	1.35	1.49	1.576	1.000	1.07	1.137
6	582	1.22	1.33	1.41	1.227	1.302	1.38
7	585	1.10	1.18	1.25	1.36	1.43	1.516
9	589	0.70	0.738	0.781	1.625	1.685	1.782
10	593	0.48	0.497	0.525	1.70	1.74	1.840

Read. No.	S.P.Fan Outlet	Capacity Actual	Capacity Corr.	Vel.P. Corr.	T.P. Corr.	Air Hp Corr.	Mech. Eff.
Units	"water	C.F.M.		"water		H.P.	%
2	0.518	4630	4830	.397	0.915	.693	36.2
3	0.736	4160	4330	.319	1.055	.718	38.6
4	0.947	3740	3890	.257	1.204	.735	41.9
5	1.180	3310	3320	.188	1.368	.712	45.2
6	1.41	2670	2770	.131	1.541	.670	47.5
7	1.538	2290	2350	.094	1.632	.602	48.2
9	1.785	920	937	.015	1.800	.265	33.9
10	1.84	000	000	000	1.84	000	00.0

TABULATED RESULTS

15 Streamlined Blades, 20 Degree Back Angle

Read. No.	Speed	Power Input to Fan			Static Pressure		
		Actual	Const. Speed	Std. Air	Actual	Const. Speed	Std. Air
Units	R.P.M.	Horsepower			Inches of Water		
1	571	1.615	1.867	1.98	0.000	0.000	0.000
2	574	1.55	1.768	1.876	0.3505	0.383	0.412
3	575	1.50	1.70	1.804	0.552	0.60	0.641
4	577	1.40	1.57	1.665	0.749	0.81	0.863
5	578	1.30	1.451	1.54	0.974	1.05	1.117
6	581	1.18	1.298	1.378	1.28	1.365	1.449
7	584	1.09	1.177	1.25	1.343	1.42	1.509
8	587	0.96	1.022	1.084	1.467	1.532	1.627
9	590	0.68	0.713	0.756	1.602	1.655	1.757
10	593	0.47	0.486	0.515	1.667	1.703	1.810

Read. No.	S.P.Fan Outlet	Capacity Actual	Capacity Corr.	Vel.P. Corr.	T.P. Corr.	Air Hp Corr.	Mech. Eff.
Units	"water	C.F.M.		"water		H.P.	%
2	0.501	4550	4760	.385	0.886	.662	35.3
3	0.712	4080	4260	.303	1.020	.682	37.8
4	0.920	3685	3830	.249	1.169	.703	42.2
5	1.159	3165	3280	.183	1.342	.690	44.9
6	1.480	2730	2820	.135	1.615	.714	51.8
7	1.53	2280	2340	.093	1.623	.596	47.7
8	1.64	1800	1840	.057	1.697	.490	45.2
9	1.76	910	925	.015	1.775	.258	34.1
10	1.81	000	000	000	1.81	000	00.0

TABULATED RESULTS

15 Streamlined Blades, 25 Degree Back Angle

Read. No.	Speed	Power Input to Fan			Static Pressure		
		Actual	Const. Speed	Std. Air	Actual	Const. Speed	Std. Air
Units	R.P.M.	Horsepower			Inches of Water		
1	576	1.45	1.633	1.717	0.000	0.000	0.000
2	377	1.40	1.568	1.648	0.334	0.361	0.384
3	578	1.37	1.53	1.608	0.529	0.57	0.603
4	580	1.32	1.46	1.535	0.722	0.772	0.815
5	580	1.26	1.392	1.462	0.948	1.015	1.069
6	583	1.15	1.25	1.313	1.163	1.231	1.294
7	584	1.04	1.123	1.18	1.30	1.372	1.443
8	585	0.94	1.01	1.061	1.43	1.503	1.579
9	590	0.68	0.71	0.746	1.557	1.608	1.69
10	593	0.48	0.496	0.521	1.625	1.66	1.745

Read. No.	S.P.Fan Outlet	Capacity Actual	Capacity Corr.	Vel.P. Corr.	T.P. Corr.	Air Hp Corr.	Mech. Eff.
Units	"water	C.F.M.		"water		H.P.	%
2	0.467	4420	4600	.360	0.827	.596	36.2
3	0.670	3980	4130	.290	0.960	.624	38.8
4	0.870	3600	3730	.236	1.106	.648	42.2
5	1.110	3110	3220	.176	1.286	.651	44.5
6	1.322	2590	2665	.121	1.443	.605	46.0
7	1.464	2230	2290	.089	1.553	.558	47.3
8	1.592	1767	1813	.056	1.648	.469	44.2
9	1.693	900	915	.014	1.707	.245	32.9
10	1.745	000	000	000	1.745	000	00.0

TABULATED RESULTS

15 Streamlined Blades, 30 Degree Back Angle

Read. No.	Speed	Power Input to Fan			Static Pressure		
		Actual	Const. Speed	Std. Air	Actual	Const. Speed	Std. Air
Units	R.P.M.	Horsepower			Inches of Water		
1	577	1.41	1.579	1.645	0.000	0.000	0.000
2	580	1.335	1.475	1.538	0.326	0.349	0.369
3	581	1.27	1.395	1.454	0.503	0.537	0.563
4	582	1.23	1.343	1.40	0.687	0.73	0.763
5	582	1.16	1.266	1.32	0.912	0.968	1.011
6	583	1.08	1.176	1.255	1.143	1.21	1.262
7	585	0.98	1.053	1.098	1.274	1.34	1.397
8	587	0.86	0.916	0.955	1.402	1.465	1.526
9	588	0.61	0.647	0.675	1.535	1.586	1.651
10	592	0.43	0.447	0.466	1.59	1.633	1.700

Read. No.	S.P.Fan Outlet	Capacity Actual	Capacity Corr.	Vel.P. Corr.	T.P. Corr.	Air Hp Corr.	Mech. Eff.
Units	"water	C.F.M.		"water		H.P.	%
2	0.446	4350	4500	.343	0.789	.556	36.2
3	0.625	3875	3995	.271	0.896	.561	38.6
4	0.815	3525	3630	.223	1.038	.582	42.3
5	1.050	3045	3140	.167	1.217	.599	45.4
6	1.289	2560	2635	.118	1.407	.582	47.5
7	1.417	2203	2262	.087	1.504	.535	48.7
8	1.538	1745	1782	.054	1.592	.445	46.6
9	1.654	885	896	.014	1.668	.234	34.7
10	1.70	000	000	000	1.70	000	00.0

TABULATED RESULTS

30 Streamlined Blades, Radial

Read. No.	Speed	Power Input to Fan			Static Pressure		
		Actual Speed	Const. Speed	Std. Air	Actual	Const. Speed	Std. Air
Units	R.P.M.	Horsepower			Inches of Water		
4	565	1.58	1.895	2.04	0.801	0.904	0.980
5	567	1.41	1.667	1.797	1.036	1.16	1.255
6	576	1.24	1.40	1.51	1.26	1.37	1.481
7	576	1.08	1.22	1.315	1.358	1.475	1.592
8	581	0.88	0.965	1.04	1.485	1.585	1.711
9	585	0.61	0.656	0.707	1.66	1.745	1.881
10	588	0.47	0.498	0.537	1.82	1.89	2.035

Read. No.	S.P.Fan Outlet	Capacity Actual	Capacity Corr.	Vel.P. Corr.	T.P. Corr.	Air Hp Corr.	Mech. Eff.
Units	"water	C.F.M.		"water		H.P.	%
4	1.045	3840	4080	.282	1.327	.850	41.7
5	1.303	3300	3490	.206	1.509	.826	46.0
6	1.512	2730	2840	.136	1.648	.735	48.7
7	1.614	2310	2400	.097	1.711	.646	49.1
8	1.725	1825	1880	.060	1.785	.527	50.7
9	1.885	940	964	.016	1.901	.288	40.7
10	2.035	000	000	000	2.035	000	00.0

TABULATED RESULTS

30 Streamlined Blades, 10 Degree Back Angle

Read. No.	Speed	Power Input to Fan: Actual	Power Input to Fan: Const. Speed	Power Input to Fan: Std. Air	Static Pressure: Actual	Static Pressure: Const. Speed	Static Pressure: Std. Air
Units	R.P.M.	Horsepower	Horsepower	Horsepower	Inches of Water	Inches of Water	Inches of Water
3	572	1.52	1.75	1.887	0.581	0.639	0.696
4	574	1.46	1.665	1.795	0.802	0.876	0.950
5	578	1.34	1.495	1.613	1.03	1.111	1.204
6	581	1.16	1.273	1.373	1.257	1.34	1.449
7	583	1.01	1.10	1.187	1.36	1.44	1.558
8	586	0.87	0.93	1.003	1.476	1.55	1.672
9	588	0.61	0.647	0.698	1.65	1.715	1.850
10	590	0.45	0.472	0.509	1.80	1.857	2.00

Read. No.	S.P.Fan Outlet	Capacity Catual	Capacity Corr.	Vel.P. Corr.	T.P. Corr.	Air Hp Corr.	Mech. Eff.
Units	"water	C.F.M.	C.F.M.	"water	"water	H.P.	%
3	0.773	4230	4440	.334	1.107	.771	40.9
4	1.013	3845	4020	.274	1.287	.813	45.3
5	1.250	3290	3420	.198	1.448	.778	48.2
6	1.480	2725	2810	.134	1.614	.712	51.9
7	1.580	2310	2380	.096	1.676	.625	52.8
8	1.688	1820	1860	.059	1.747	.511	50.9
9	1.854	935	954	.015	1.869	.280	40.1
10	2.005	000	000	000	2.005	000	00.0

TABULATED RESULTS

30 Streamlined Blades, 15 Degree Back Angle

Read. No.	Speed	Power Input to Fan: Actual	Power Input to Fan: Const. Speed	Power Input to Fan: Std. Air	Static Pressure: Actual	Static Pressure: Const. Speed	Static Pressure: Std. Air
Units:	R.P.M.	Horsepower			Inches of Water		
3	581	1.46	1.603	1.73	0.576	0.614	0.670
4	583	1.39	1.512	1.633	0.783	1.83	0.901
5	586	1.28	1.37	1.48	1.023	1.073	1.162
6	588	1.15	1.22	1.318	1.247	1.297	1.403
7	590	1.02	1.07	1.156	1.365	1.41	1.526
8	592	0.87	0.904	0.976	1.49	1.53	1.655
9	594	0.61	0.628	0.678	1.63	1.663	1.797
10	598	0.44			1.79		

Read. No.	S.P.Fan Outlet	Capacity: Actual	Capacity: Corr.	Vel.P.; Corr.	T.P. Corr.	Air Hp: Corr.	Mech. Eff.
Units:	"water	C.F.M.		"water		H.P.	%
3	0.744	4210	4340	.319	1.063	.725	41.9
4	0.961	3800	3810	.260	1.221	.750	45.9
5	1.206	3280	3355	.190	1.396	.734	49.6
6	1.433	2715	2770	.130	1.563	.680	51.6
7	1.548	2315	2355	.094	1.643	.608	52.6
8	1.668	1830	1855	.058	1.726	.502	51.4
9	1.800	930	938	.015	1.815	.298	39.5
10	1.932				1.932		

TABULATED RESULTS

30 Streamlined Blades, 30 Degree Back Angle

Read. No.	Speed	Power Input to Fan			Static Pressure		
		Actual	Const. Speed	Std. Air	Actual	Const. Speed	Std. Air
Units	R.P.M.	Horsepower			Inches of Water		
4	578	1.24	1.384	1.485	0.727	0.784	0.845
5	579	1.20	1.332	1.43	0.965	1.37	1.124
6	581	1.09	1.198	1.285	1.208	1.289	1.383
7	582	0.97	1.059	1.135	1.32	1.401	1.504
8	583	0.84	0.913	0.98	1.425	1.51	1.619
9	585	0.59	0.635	0.681	1.56	1.64	1.758
10	590	0.46	0.482	0.517	1.70	1.754	1.88

Read. No.	S.P.Fan Outlet	Capacity		Vel.P. Corr.	T.P. Corr.	Air Hp Corr.	Mech. Eff.
		Actual	Corr.				
Units	"water	C.F.M.		"water		H.P.	%
4	0.901	3648	3785	.243	1.144	.680	45.8
5	1.166	3153	3268	.181	1.347	.690	48.3
6	1.413	2665	2750	.128	1.541	.666	51.8
7	1.525	2270	2338	.093	1.618	.594	52.3
8	1.630	1782	1835	.057	1.687	.486	49.6
9	1.761	907	930	.016	1.777	.360	38.1
10	1.88	000	000	000	1.88	000	00.0

TABULATED RESULTS

30 Streamlined Blades, 25 Degree Back Angle

Read. No.	Speed	Power Input to Fan			Static Pressure		
		Actual	Const. Speed	Std. Air	Actual	Const. Speed	Std. Air
Units	R.P.M.	Horsepower			Inches of Water		
4	581	1.17	1.285	1.377	0.707	0.754	0.812
5	583	1.10	1.197	1.284	0.927	0.982	1.055
6	584	1.02	1.102	1.181	1.173	1.24	1.332
7	585	0.93	1.00	1.073	1.295	1.361	1.46
8	586	0.82	0.877	0.94	1.43	1.50	1.608
9	587	0.54	0.575	0.616	1.50	1.567	1.68
10	588	0.39	0.413	0.443	1.62	1.685	1.805

Read. No.	S.P.Fan Outlet	Capacity		Vel.P. Corr.	T.P. Corr.	Air Hp Corr.	Mech. Eff.
		Actual	Corr.				
Units	"water	C.F.M.		"water		H.P.	%
4	0.866	3600	3710	.233	1.099	.626	45.5
5	1.093	3108	3200	.173	1.266	.637	49.6
6	1.360	2626	2695	.123	1.483	.629	53.2
7	1.481	2250	2307	.090	1.571	.570	53.1
8	1.621	1785	1825	.056	1.677	.471	51.2
9	1.683	890	908	.014	1.697	.241	39.2
10	1.806	000	000	000	1.806	000	00.0

TABULATED RESULTS

30 Streamlined Blades, 30 Degree Back Angle

Read. No.	Speed	Power Input to Fan			Static Pressure		
		Actual	Const. Speed	Std. Air	Actual	Const. Speed	Std. Air
Units	R.P.M.	Horsepower			Inches of Water		
4	582	1.08	1.18	1.268	0.651	0.691	0.746
5	585	1.03	1.108	1.19	0.88	0.925	0.996
6	587	0.93	0.991	1.054	1.10	1.15	11237
7	588	0.87	0.922	0.99	1.264	1.315	1.414
8	589	0.77	0.812	0.873	1.372	1.423	1.529
9	593	0.54	0.558	0.60	1.493	1.526	1.639
10	596	0.41			1.655		

Read. No.	S.P.Fan Outlet	Capacity Actual	Capacity Corr.	Vel.P. Corr.	T.P. Corr.	Air Hp Corr.	Mech. Eff.
Units	"water	C.F.M.		"water		H.P.	%
4	0.796	3455	3560	.215	1.011	.565	44.6
5	1.034	3033	3110	.164	1.198	.585	49.2
6	1.263	2543	2600	.114	1.377	.562	53.2
7	1.434	2222	2265	.087	1.521	.540	54.5
8	1.541	1750	1781	.054	1.595	.447	51.2
9	1.642	887	896	.014	1.656	.233	38.8
10	1.778	000	000	000	1.778	000	00.0

TABULATED RESULTS

6 Straight Blades

Read. No.	Speed	Power Input to Fan: Actual	Power Input to Fan: Const. Speed	Power Input to Fan: Std. Air	Static Pressure: Actual	Static Pressure: Const. Speed	Static Pressure: Std. Air
Units	R.P.M.	Horsepower	Horsepower	Horsepower	Inches of Water	Inches of Water	Inches of Water
			Radial				
5	581	1.345	1.48	1.60	0.975	1.037	1.122
6	583	1.21	1.315	1.42	1.235	1.31	1.416
7	586	1.075	1.15	1.24	1.373	1.44	1.558
8	588	0.915	0.97	1.045	1.455	1.514	1.637
			10 Degree Back Angle				
5	581	1.305	1.43	1.545	0.943	1.005	1.089
6	583	1.20	1.305	1.41	1.20	1.27	1.373
7	585	1.07	1.15	1.24	1.33	1.40	1.514
8	588	0.90	0.954	1.03	1.417	1.472	1.590

Read. No.	S.P.Fan Outlet	Capacity: Actual	Capacity: Corr.	Vel.P.: Corr.	T.P.: Corr.	Air Hp: Corr.	Mech.: Eff.
Units	"water	C.F.M.	C.F.M.	"water	"water	H.P.	%
				Radial			
5	1.165	3200	3300	.185	1.350	.700	43.7
6	1.446	2700	2780	.131	1.577	.688	48.5
7	1.580	2325	2385	.096	1.676	.619	50.7
8	1.650	1805	1840	.057	1.707	.493	47.2
				10 Degree Back Angle			
5	1.130	3150	3250	.179	1.309	.667	43.2
6	1.402	2660	2735	.127	1.529	.657	46.6
7	1.535	2290	2350	.093	1.628	.591	48.5
8	1.603	1780	1815	.056	1.650	.477	45.8

TABULATED RESULTS

6 Straight Blades

Read. No.	Speed	Power Input to Fan: Actual	Power Input to Fan: Const. Speed	Power Input to Fan: Std. Air	Static Pressure: Actual	Static Pressure: Const. Speed	Static Pressure: Std. Air
Units	R.P.M.	Horsepower	Horsepower	Horsepower	Inches of Water	Inches of Water	Inches of Water
			15 Degree Back Angle				
5	581	1.27	1.395	1.507	0.921	0.982	1.065
6	585	1.14	1.227	1.325	1.163	1.222	1.322
7	586	1.02	1.09	1.177	1.287	1.35	1.46
8	588	0.87	0.922	0.995	1.372	1.428	1.543
			20 Degree Back Angle				
5	583	1.235	1.34	1.45	0.89	0.941	1.021
6	584	1.14	1.23	1.33	1.12	1.183	1.28
7	586	0.99	1.06	1.146	1.246	1.306	1.413
8	588	0.84	0.89	0.962	1.34	1.393	1.508

Read. No.	S.P.Fan Outlet	Capacity Actual	Capacity Corr.	Vel.P. Corrl	T.P. Corr.	Air Hp Corr.	Mech. Eff.
Units	"water	C.F.M.	C.F.M.	"water	"water	H.P.	%
			15 Degree Back Angle				
5	1.105	3110	3210	.174	1.279	.645	43.8
6	1.350	2620	2690	.123	1.473	.623	47.0
7	1.481	2250	2300	.090	1.571	.573	48.7
8	1.555	1755	1790	.054	1.609	.452	45.4
			20 Degree Back Angle				
5	1.060	3060	3150	.168	1.228	.608	41.9
6	1.307	2570	2635	.118	1.425	.605	45.3
7	1.433	2210	2260	.087	1.520	.540	47.1
8	1.520	1735	1770	.053	1.573	.437	45.4

TABULATED RESULTS

6 Straight Blades

Read. No.	Speed	Power Input to Fan: Actual	Power Input to Fan: Const. Speed	Power Input to Fan: Std. Air	Static Pressure: Actual	Static Pressure: Const. Speed	Static Pressure: Std. Air
Units	R.P.M.	Horsepower	Horsepower	Horsepower	Inches-of Water	Inches-of Water	Inches-of Water
		25 Degree Back Angle					
5	584	1.17	1.265	1.365	0.867	0.915	0.991
6	585	1.04	1.12	1.21	1.09	1.145	1.239
7	587	0.95	1.01	1.09	1.213	1.27	1.372
8	589	0.81	0.854	0.92	1.303	1.352	1.46
		30 Degree Back Angle					
5	584	1.14	1.23	1.33	0.837	0.884	0.956
6	586	1.01	1.08	1.165	1.05	1.10	1.189
7	588	0.91	0.965	1.04	1.167	1.213	1.311
8	589	0.77	0.812	0.870	1.265	1.312	1.418

Read. No.	S.P.Fan Outlet	Capacity Actual	Capacity Corr.	Vel.P. Corr.	T.P. Corr.	Air Hp Corr.	Mech. Eff.
Units	"water	C.F.M.	C.F.M.	"water	"water	H.P.	%
		25 Degree Back Angle					
5	1.028	3020	3100	.162	1.190	.580	42.5
6	1.266	2540	2605	.115	1.381	.565	46.7
7	1.391	2185	2230	.084	1.475	.516	47.4
8	1.472	1710	1745	.051	1.523	.418	45.4
		30 Degree Back Angle					
5	0.992	2965	3040	.156	1.148	.541	41.2
6	1.214	2490	2550	.110	1.324	.531	45.6
7	1.330	2140	2185	.081	1.411	.485	46.6
8	1.430	1680	1715	.050	1.480	.399	45.8

TABULATED RESULTS

10 Straight Blades

Read. No.	Speed	Power Input to Fan			Static Pressure		
		Actual	Const. Speed	Std. Air	Actual	Const. Speed	Std. Air
Units	R.P.M.	Horsepower			Inches of Water		
				Radial			
5	577	1.48	1.656	1.78	1.077	1.163	1.254
6	580	1.33	1.47	1.58	1.355	1.45	1.561
7	582	1.19	1.30	1.40	1.47	1.56	1.679
8	586	1.02	1.09	1.17	1.57	1.647	1.771
				10 Degree Back Angle			
5	579	1.40	1.554	1.67	1.051	1.13	1.218
6	582	1.26	1.375	1.48	1.312	1.393	1.500
7	585	1.12	1.205	1.295	1.435	1.51	1.625
8	587	0.96	1.024	1.10	1.537	1.606	1.727

Read. No.	S.P.Fan Outlet	Capacity Actual	Capacity Corr.	Vel.P. Corr.	T.P. Corr.	Air Hp Corr.	Mech. Eff.
Units	"water	C.F.M.		"water		H.P.	%
				Radial			
5	1.302	3360	3490	.206	1.508	.825	46.4
6	1.595	2830	2930	.145	1.740	.800	50.6
7	1.703	2405	2480	.104	1.807	.705	50.2
8	1.785	1875	1920	.062	1.847	.558	47.7
				10 Degree Back Angle			
5	1.264	3320	3440	.200	1.464	.790	47.3
6	1.532	2780	2865	.139	1.671	.754	50.9
7	1.648	2365	2425	.100	1.748	.665	.51.4
8	1.741	1855	1895	.061	1.802	.537	48.8

TABULATED RESULTS

10 Straight Blades

Read. No.	Speed	Power Input to Fan: Actual	Power Input to Fan: Const. Speed	Power Input to Fan: Std. Air	Static Pressure: Actual	Static Pressure: Const. Speed	Static Pressure: Std. Air
Units:	R.P.M.	Horsepower	Horsepower	Horsepower	Inches of Water	Inches of Water	Inches of Water
			15 Degree Back Angle				
5	582	1.35	1.472	1.58	1.02	1.083	1.167
6	584	1.23	1.33	1.43	1.276	1.347	1.449
7	586	1.10	1.18	1.27	1.406	1.475	1.587
8	588	0.92	0.975	1.047	1.50	1.56	1.678
			20 Degree Back Angle				
5	582	1.31	1.43	1.535	0.993	1.053	1.042
6	584	1.21	1.31	1.41	1.247	1.317	1.419
7	586	1.055	1.13	1.215	1.361	1.428	1.537
8	588	0.903	0.957	1.028	1.463	1.522	1.637

Read. No.	S.P.Fan Outlet	Capacity Actual	Capacity Corr.	Vel.P. Corr.	T.P. Corr.	Air Hp Corr.	Mech. Eff.
Units:	"water	C.F.M.	C.F.M.	"water	"water	H.P.	%
				15 Degree Back Angle			
5	1.211	3270	3370	.192	1.403	.742	47.0
6	1.480	2745	2820	.134	1.614	.716	50.0
7	1.610	2350	2405	.098	1.708	.645	50.8
8	1.692	1835	1870	.059	1.751	.515	49.2
				20 Degree Back Angle			
5	1.185	3225	3320	.186	1.371	.715	46.6
6	1.449	2710	2780	.131	1.580	.690	48.9
7	1.559	2310	2365	.095	1.654	.615	50.6
8	1.650	1810	1850	.058	1.708	.495	48.2

TABULATED RESULTS

10 Straight Blades

Read. No.	Speed	Power Input to Fan: Actual	Power Input to Fan: Const. Speed	Power Input to Fan: Std. Air	Static Pressure: Actual	Static Pressure: Const. Speed	Static Pressure: Std. Air
Units	R.P.M.	Horsepower	Horsepower	Horsepower	Inches of Water	Inches of Water	Inches of Water
25 Degree Back Angle							
5	581	1.29	1.415	1.517	0.956	1.018	1.094
6	583	1.17	1.273	1.365	1.206	1.278	1.371
7	586	1.04	1.134	1.205	1.336	1.401	1.504
8	588	0.89	0.943	1.01	1.43	1.488	1.597
30 Degree Back Angle							
5	584	1.25	1.35	1.445	0.921	0.973	1.045
6	585	1.12	1.205	1.30	1.16	1.22	1.309
7	587	1.02	1.09	1.17	1.28	1.337	1.433
8	588	0.88	0.932	1.00	1.363	1.42	1.523

Read. No.	S.P.Fan Outlet	Capacity Actual	Capacity Corr.	Vel.P. Corr.	T.P. Corr.	Air Hp Corr.	Mech. Eff.
Units	"water	C.F.M.	C.F.M.	"water	"water	H.P.	%
25 Degree Back Angle							
5	1.156	3160	3260	.180	1.316	.674	44.4
6	1.400	2660	2740	.127	1.527	.657	43.1
7	1.525	2285	2340	.093	1.618	.594	43.3
8	1.610	1785	1820	.056	1.666	.475	47.1
30 Degree Back Angle							
5	1.085	3100	3180	.171	1.256	.627	43.4
6	1.337	2610	2690	.122	1.459	.616	47.4
7	1.453	2235	2255	.083	1.539	.540	46.2
8	1.535	1750	1785	.054	1.589	.479	43.6

TABULATED RESULTS

15 Straight Blades

Read. No.	Speed	Power Input to Fan			Static Pressure		
		Actual	Const. Speed	Std. Air	Actual	Const. Speed	Std. Air
Units	R.P.M.	Horsepower			Inches of Water		
				Radial			
5	578	1.48	1.652	1.785	1.072	1.156	1.253
6	582	1.30	1.420	1.532	1.387	1.410	1.528
7	582	1.16	1.266	1.367			
8	586	1.00	1.070	1.155	1.567	1.642	1.774
				10 Degree Back Angle			
5	578	1.41	1.573	1.700	1.04	1.122	1.214
6	582	1.23	1.344	1.451	1.285	1.365	1.476
7	584	1.10	1.188	1.282	1.43	1.521	1.644
8	586	0.95	1.016	1.097	1.533	1.609	1.739

Read. No.	S.P.Fan Outlet	Capacity Actual	Capacity Corr.	Vel.P. Corr.	T.P. Corr.	Air Hp Corr.	Mech. Eff.
Units	"water	C.F.M.		"water		H.P.	%
				Radial			
5	1.300	3360	3485	.205	1.505	.823	46.1
6	1.580	2800	2885	.140	1.700	.771	50.3
7							
8	1.790	1875	1920	.062	1.852	.557	48.3
				10 Degree Back Angle			
5	1.260	3310	3440	.200	1.460	.799	46.4
6	1.507	2750	2830	.136	1.643	.745	51.3
7	1.668	2370	2435	.0995	1.768	.676	52.7
8	1.753	1855	1900	.061	1.834	.548	49.9

TABULATED RESULTS

15 Straight Blades

Read. No.	Speed	Power Input to Fan: Actual	Power Input to Fan: Const. Speed	Power Input to Fan: Std. Air	Static Pressure: Actual	Static Pressure: Const. Speed	Static Pressure: Std. Air
Units:	R.P.M.	Horsepower	Horsepower	Horsepower	Inches of Water	Inches of Water	Inches of Water
		20 Degree Back Angle					
5	582	1.30	1.420	1.525	0.997	1.060	1.141
6	584	1.15	1.242	1.335	1.23	1.298	1.397
7	586	1.04	1.113	1.196	1.37	1.436	1.545
8	587	0.90	0.958	1.028	1.487	1.539	1.660
		30 Degree Back Angle					
5	583	1.20	1.305	1.401	0.932	0.988	1.062
6	586	1.08	1.156	1.241	1.168	1.223	1.317
7	588	0.97	1.037	1.114	1.307	1.370	1.476
8	589	0.84	0.885	0.95	1.413	1.467	1.581

Read. No.	S.P.Fan Outlet	Capacity Actual	Capacity Corr.	Vel.P. Corr.	T.P. Corr.	Air Hp Corr.	Mech. Eff.
Units:	"water	C.F.M.	C.F.M.	"water	"water	H.P.	%
			20 Degree Back Angle				
5	1.184	3230	3330	.188	1.372	.718	47.1
6	1.427	3690	2760	.129	1.556	.675	50.5
7	1.567	2320	2370	.095	1.662	.618	51.7
8	1.674	1825	1863	.059	1.733	.507	49.3
			30 Degree Back Angle				
5	1.102	3125	3220	.175	1.277	.641	46.1
6	1.345	2620	2680	.121	1.466	.617	49.7
7	1.497	2260	2310	.090	1.587	.575	51.6
8	1.594	1775	1810	.055	1.649	.467	49.2

TABULATED RESULTS

30 Straight Blades

Read. No.	Speed	Power Input to Fan			Static Pressure		
		Actual	Const. Speed	Std. Air	Actual	Const. Speed	Std. Air
Units	R.P.M.	Horsepower			Inches of Water		
				Radial			
5	578	1.50	1.68	1.813	1.093	1.179	1.277
6	581	1.36	1.493	1.611	1.343	1.432	1.549
7	584	1.16	1.253	1.353	1.468	1.550	1.676
8	587	0.98	1.045	1.129	1.560	1.630	1.761
				10 Degree Back Angle			
5	580	1.45	1.60	1.723	1.056	1.130	1.224
6	583	1.28	1.392	1.500	1.292	1.369	1.480
7	585	1.15	1.237	1.332	1.405	1.476	1.597
8	588	1.00	1.060	1.141	1.508	1.568	1.696

Read. No.	S.P.Fan Outlet	Capacity Actual	Capacity Corr.	Vel.P. Corr.	T.P. Corr.	Air Hp Corr.	Mech. Eff.
Units	"water	C.F.M.		"water		H.P.	%
				Radial			
5	1.325	3390	3520	.210	1.535	.850	46.8
6	1.582	2820	2910	.143	1.725	.788	48.9
7	1.700	2400	2465	.103	1.803	.678	50.1
8	1.775	1870	1910	.062	1.837	.551	48.8
				10 Degree Back Angle			
5	1.270	3330	3445	.200	1.470	.768	44.6
6	1.511	2760	2840	.136	1.647	.735	49.0
7	1.620	2350	2410	.098	1.718	.650	48.8
8	1.710	1840	1876	.058	1.769	.520	45.6

TABULATED RESULTS

30 Straight Blades

Read. No.	Speed	Power Input to Fan			Static Pressure		
		Actual	Const. Speed	Std. Air	Actual	Const. Speed	Std. Air
Units	R.P.M.	Horsepower			Inches of Water		
		15 Degree Back Angle					
5	580	1.42	1.57	1.693	1.026	1.097	1.186
6	584	1.25	1.35	1.455	1.268	1.339	1.446
7	585	1.10	1.183	1.276	1.383	1.452	1.568
8	586	0.95	1.016	1.095	1.511	1.585	1.710
		20 Degree Back Angle					
5	582	1.38	1.506	1.623	1.003	1.065	1.150
6	584	1.21	1.307	1.410	1.242	1.311	1.415
7	586	1.09	1.167	1.269	1.380	1.447	1.559
8	587	0.96	1.022	1.102	1.485	1.551	1.673

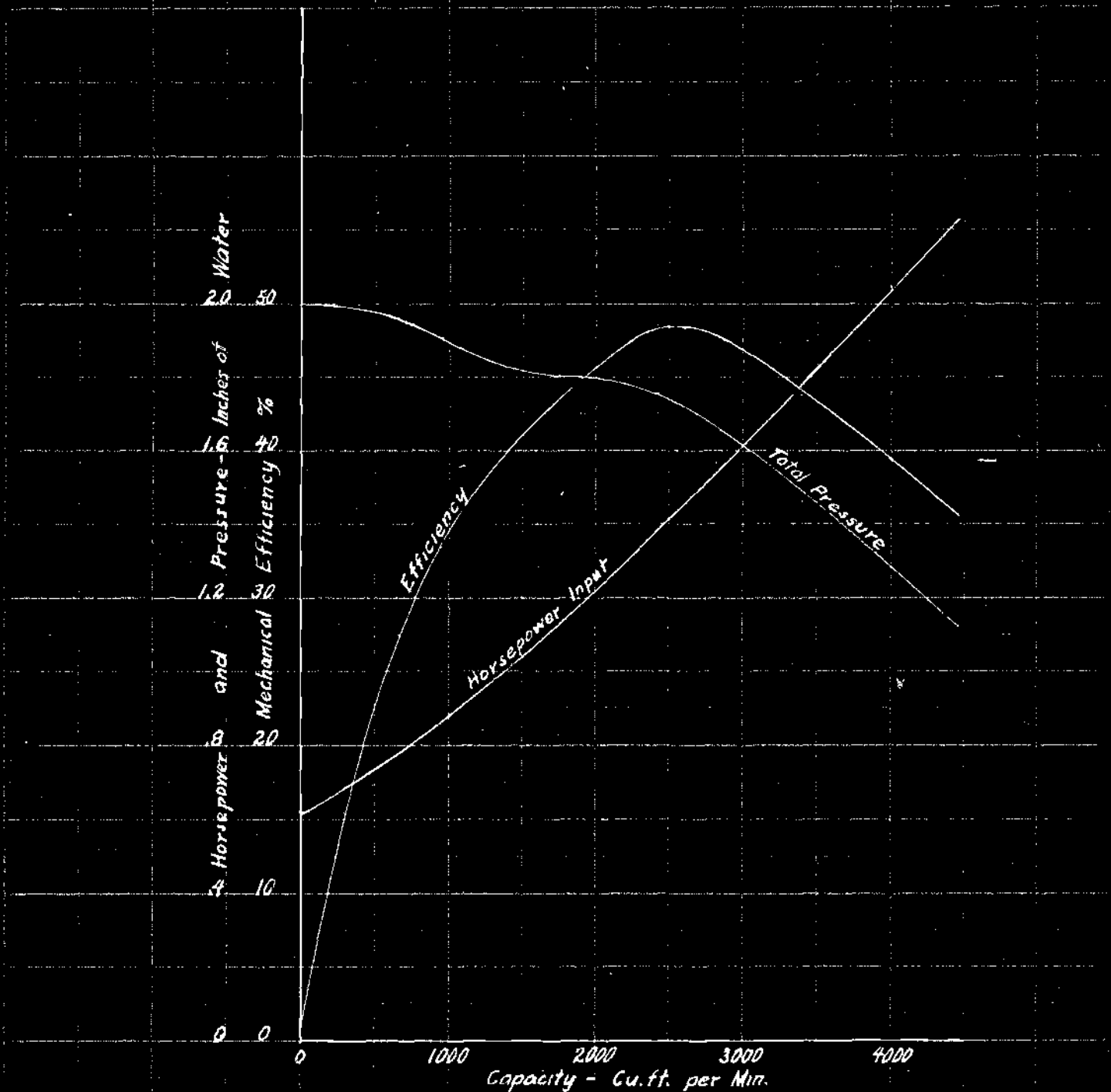
Read. No.	S.P.Fan Outlet	Capacity Actual	Capacity Corr.	Vel.P. Corr.	T.P. Corr.	Air Hp Corr.	Mech. Eff.
Units	"water	C.F.M.		"water		H.P.	%
		15 Degree Back Angle					
5	1.231	3285	3400	.196	1.427	.762	45.0
6	1.477	2740	2814	.134	1.611	.712	48.9
7	1.590	2330	2390	.097	1.687	.633	49.6
8	1.724	1840	1883	.060	1.784	.576	48.2
		20 Degree Back Angle					
5	1.193	3245	3340	.188	1.381	.725	44.7
6	1.445	2710	2785	.131	1.576	.688	48.8
7	1.581	2330	2385	.096	1.677	.628	49.5
8	1.687	1825	1865	.059	1.746	.511	46.4

TABULATED RESULTS

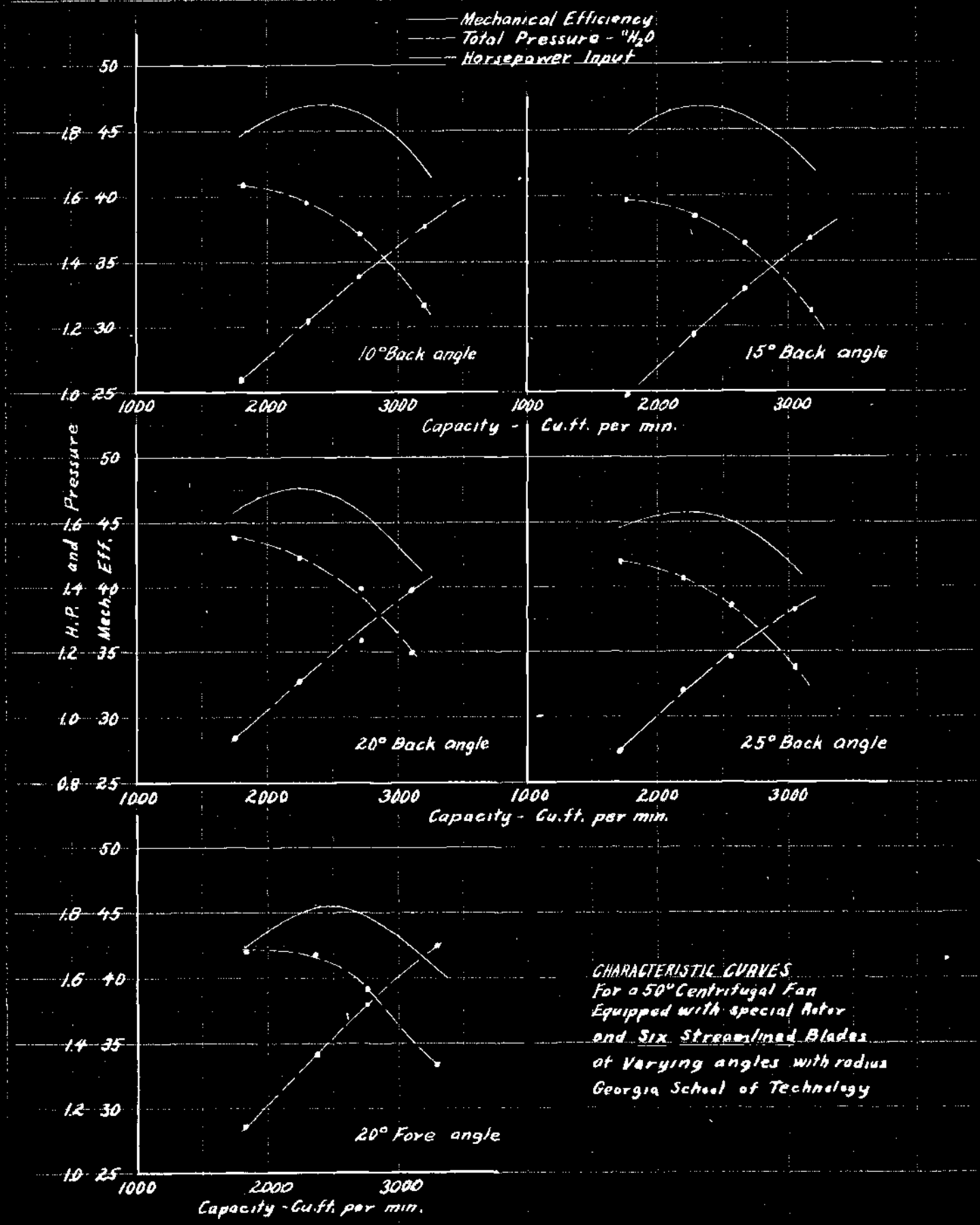
30 Straight Blades

Read. No.	Speed	Power Input to Fan			Static Pressure		
		Actual	Const. Speed	Std. Air	Actual	Const. Speed	Std. Air
Units	R.P.M.	Horsepower			Inches of Water		
		25 Degree Back Angle					
5	582	1.28	1.397	1.509	0.974	1.035	1.121
6	585	1.17	1.26	1.36	1.210	1.271	1.375
7	586	1.04	1.113	1.202	1.335	1.400	1.514
8	587	0.92	0.981	1.057	1.445	1.510	1.633

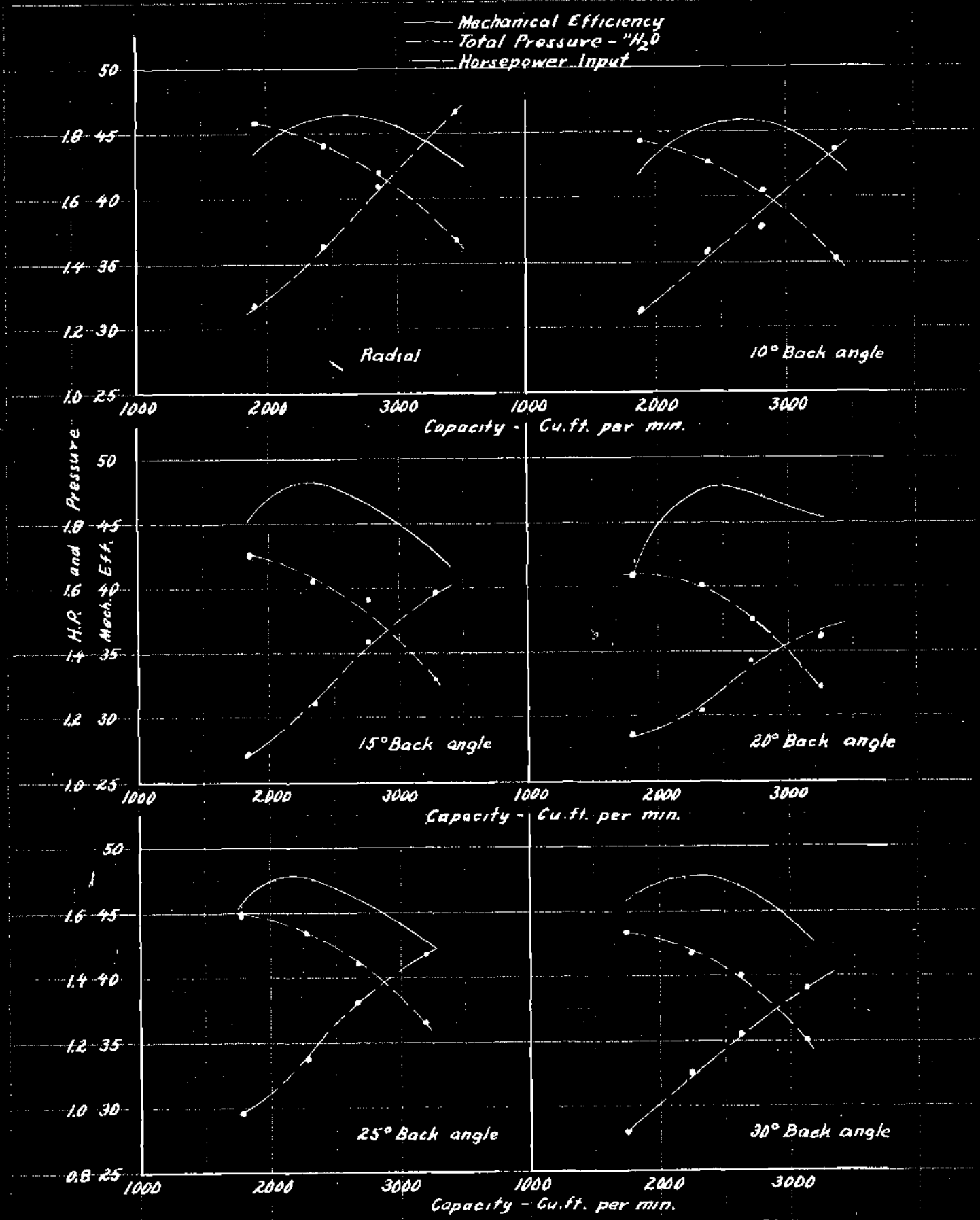
Read. No.	S.P.Fan Outlet	Capacity Actual	Capacity Corr.	Vel.P. Corr.	T.P. Corr.	Air Hp Corr.	Mech. Eff.
Units	"water	C.F.M.		"water		H.P.	%
		25 Degree Back Angle					
5	1.163	3200	3295	.184	1.347	.695	46.1
6	1.406	2740	2810	.134	1.540	.679	49.9
7	1.535	2290	2345	.093	1.628	.600	49.8
8	1.645	1800	1840	.057	1.702	.492	46.6



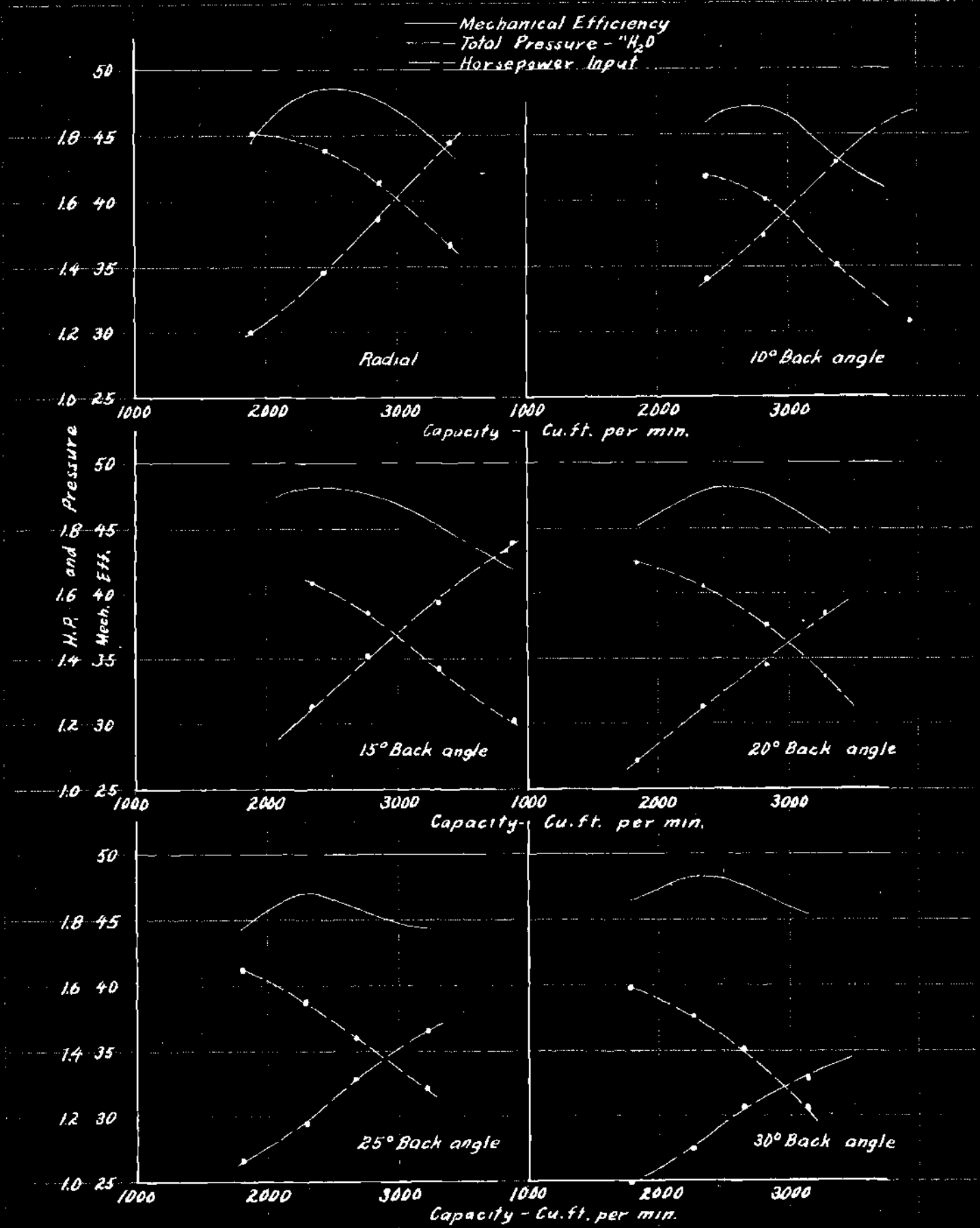
Characteristic Curves for
50" Centrifugal Fan
Using 15 ~~Streamlined~~
Blades Radial - with
Special Rotor
Georgia School of Technology



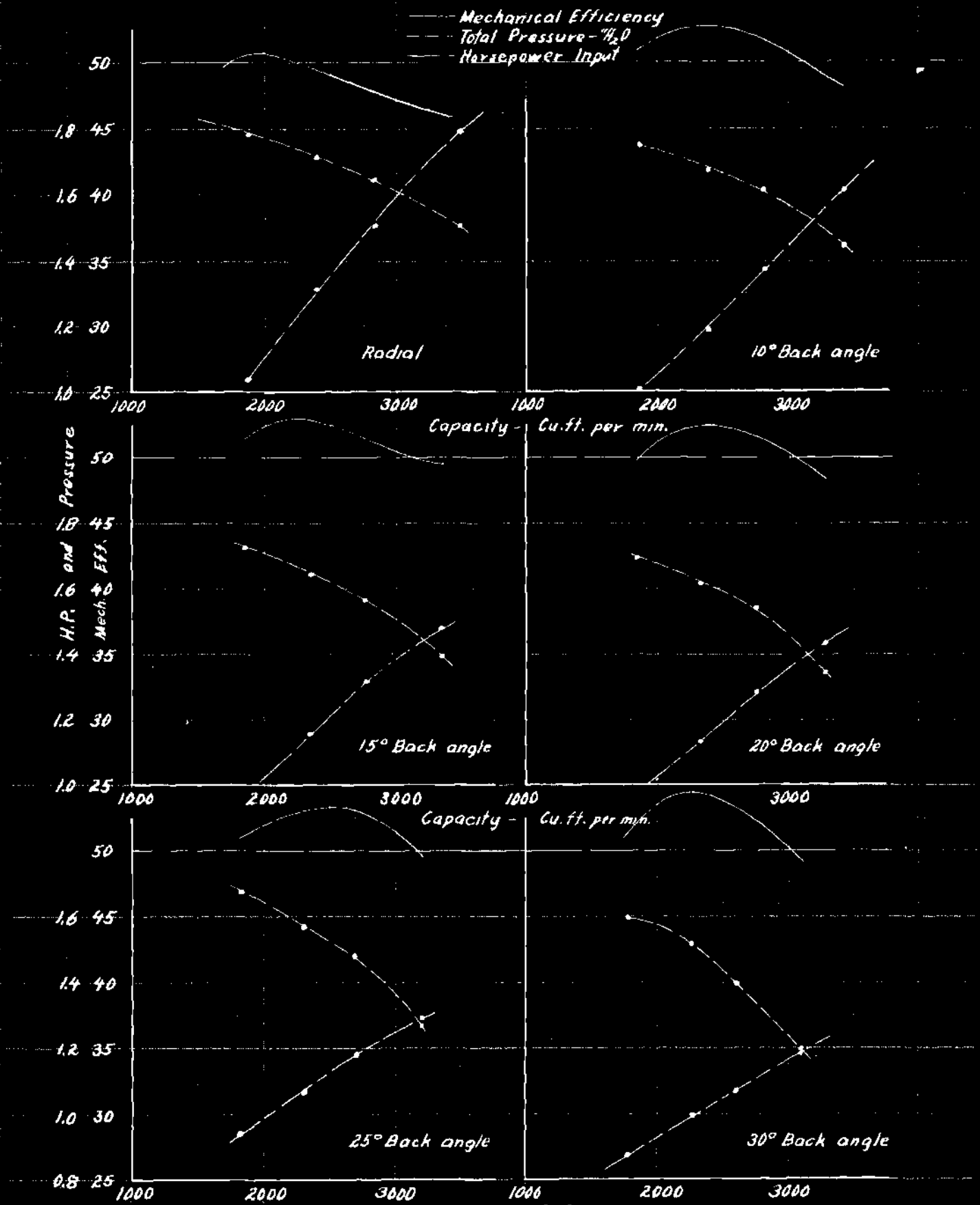
CHARACTERISTIC CURVES
For a 50° Centrifugal Fan
Equipped with special Rotor
and Six Streamlined Blades
at Varying angles with radius
Georgia School of Technology



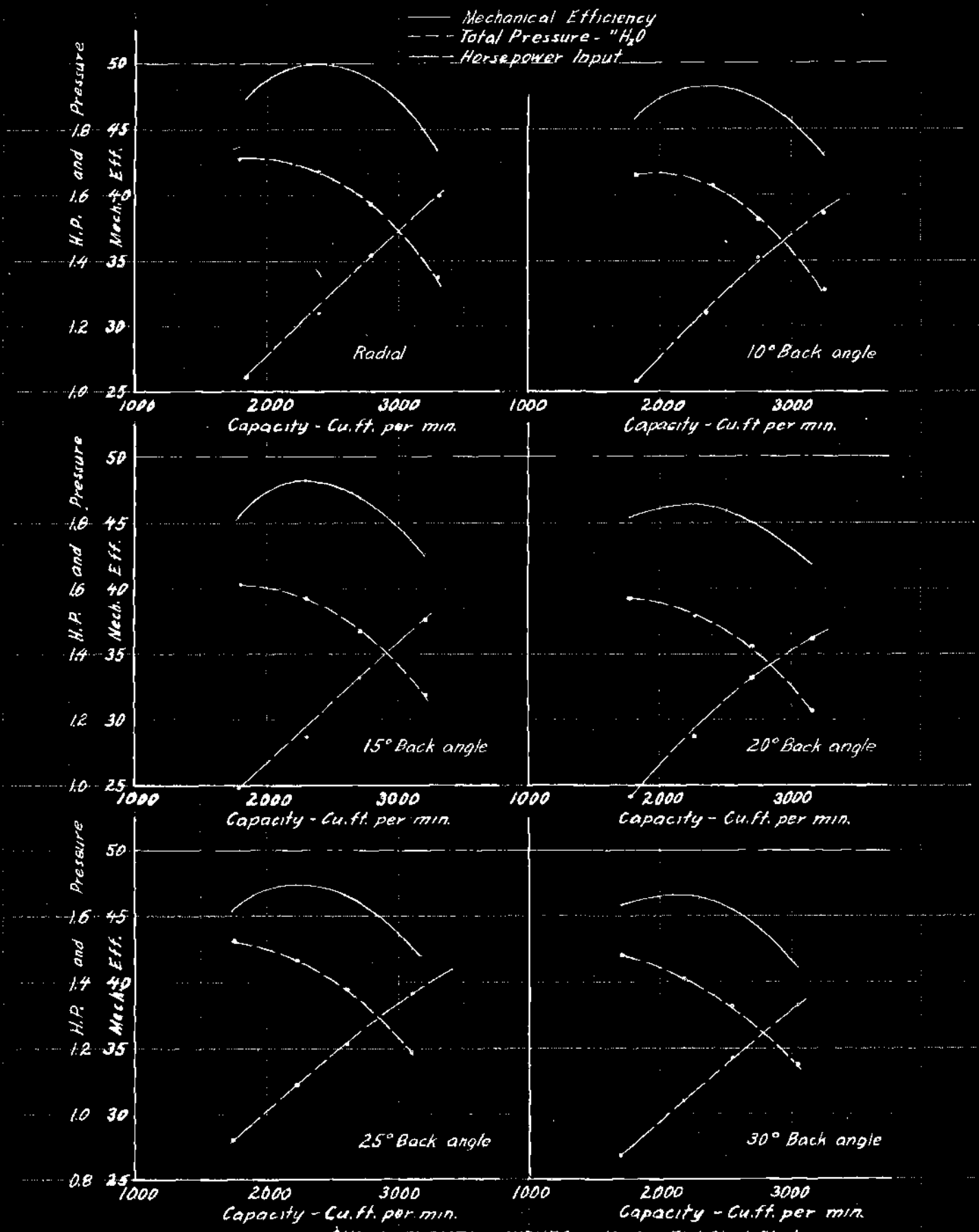
CHARACTERISTIC CURVES with Ten Streamlined Blades



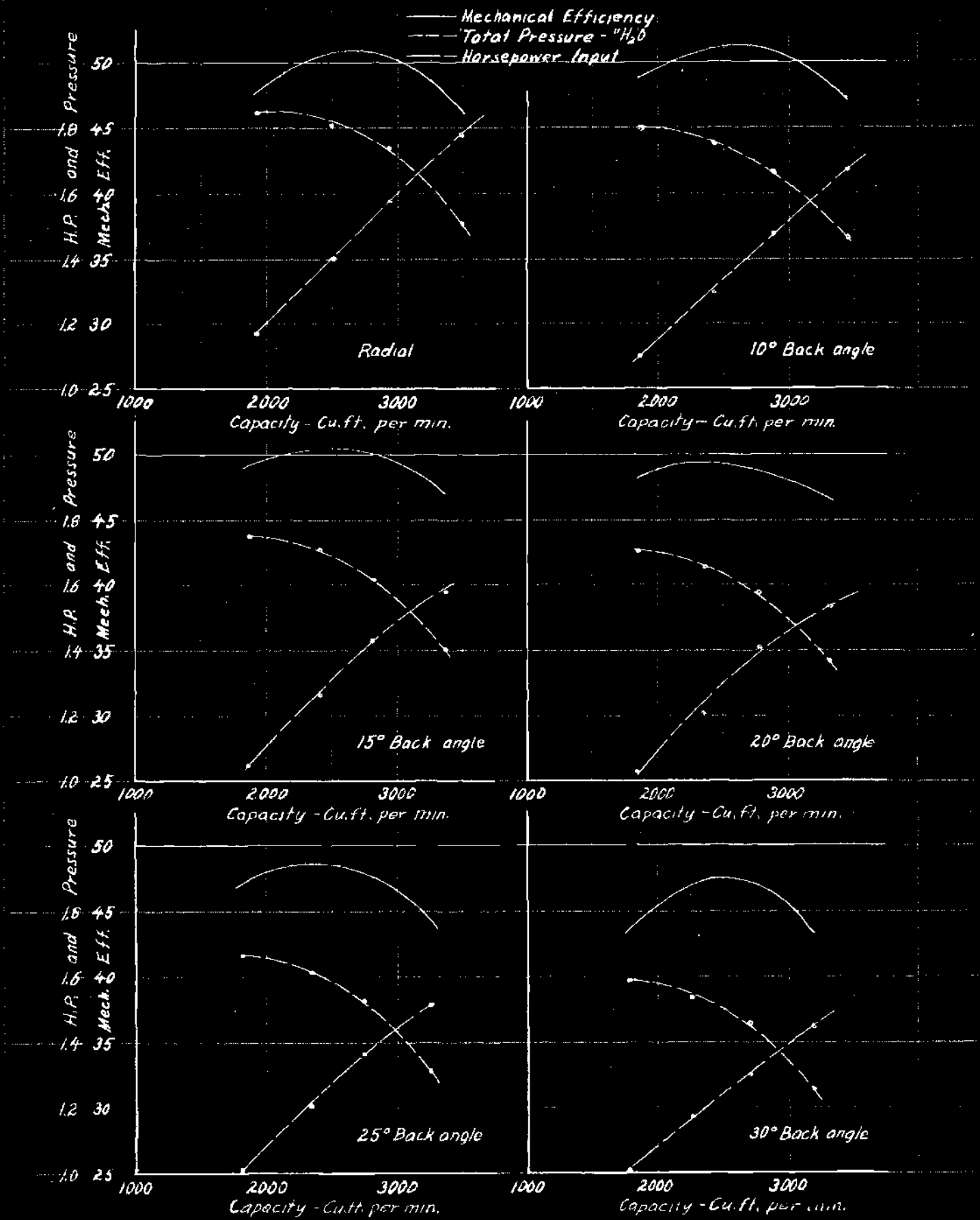
CHARACTERISTIC CURVES with Fifteen Streamlined Blades



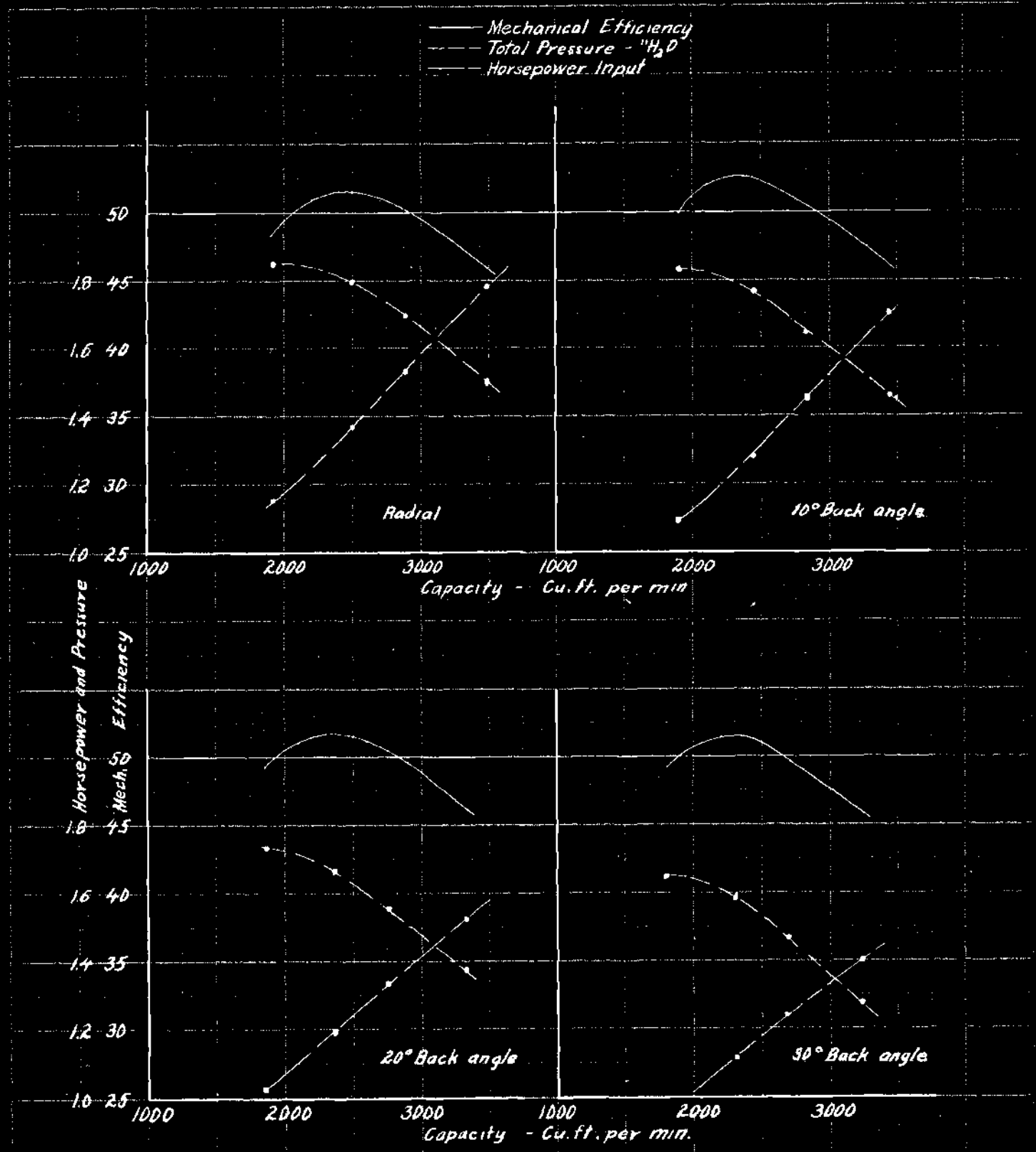
CHARACTERISTIC CURVES with Thirty Streamlined Blades



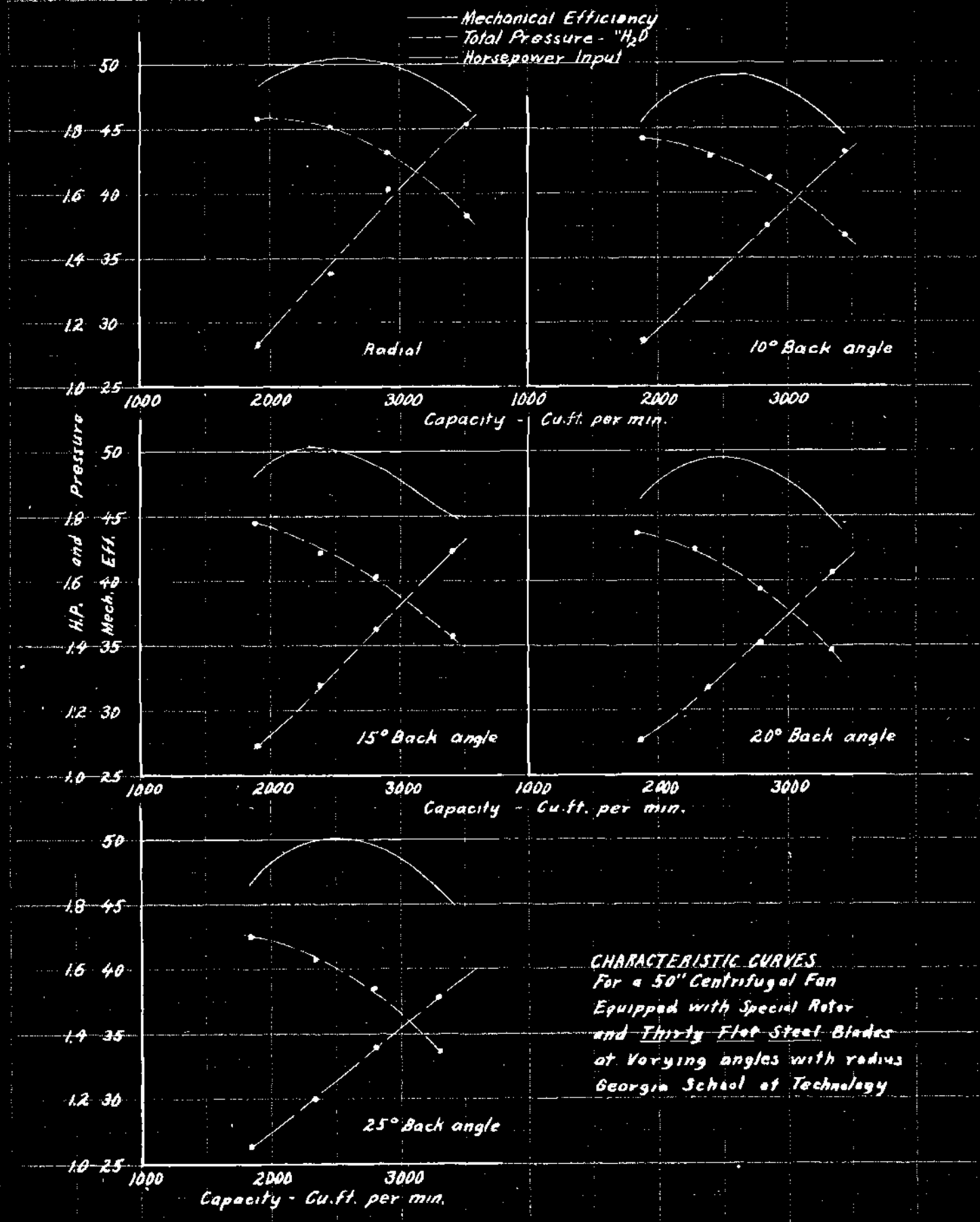
CHARACTERISTIC CURVES with Six Flat Steel Blades



CHARACTERISTIC CURVES with Ten Flat Steel Blades



CHARACTERISTIC CURVES
For a 50" Centrifugal Fan
Equipped with Special Rotor
and Fifteen Flat Steel Blades



CHARACTERISTIC CURVES
For a 50" Centrifugal Fan
Equipped with Special Rotor
and Thirty Flat Steel Blades
at Varying angles with radius
Georgia School of Technology

RESULTS FROM CURVES

Streamlined Blades

6 Blades

Max. Eff. = 47.6%
Av. of Max. Eff. = 46.5%
Average Capacity = 2325

Blade Angle Degree	T.P. at 2500 "water	Cap. at Max. Eff. C.F.M.	Max. Eff. %
0			
10	1.54	2450	47.0
15	1.49	2350	46.8
20	1.44	2250	47.6
25	1.36	2250	45.7

10 Blades

Max. Eff. = 48.2%
Av. of Max. Eff. = 47.4%
Average Capacity = 2425

Blade Angle Degree	T.P. at 2500 "water	Cap. at Max. Eff. C.F.M.	Max. Eff. %
0	1.75	2650	46.5
10	1.68	2650	46.0
15	1.60	2300	48.2
20	1.56	2450	47.8
25	1.49	2200	47.8
30	1.42	2300	47.7

15 Blades

Max. Eff. = 48.5%
Av. of Max. Eff. = 47.8%
Average Capacity = 2475

Blade Angle Degree	T.P. at 2500 "water	Cap. at Max. Eff. C.F.M.	Max. Eff. %
0	1.74	2550	48.5
10	1.66	2700	47.1
15	1.60	2400	48.1
20	1.59	2550	48.1
25	1.49	2300	47.0
30	1.44	2350	48.2

30 Blades

Max. Eff. = 54.4%
Av. of Max. Eff. = 52.8%
Average Capacity = 2308

Blade Angle Degree	T.P. at 2500 "water	Cap. at Max. Eff. C.F.M.	Max. Eff. %
0	1.70	2000	50.7
10	1.66	2400	52.7
15	1.62	2350	53.0
20	1.59	2400	52.5
25	1.53	2550	53.3
30	1.44	2250	54.4

Straight Blades

6 Blades

Max. Eff. = 50.0%
Av. of Max. Eff. = 47.9%
Average Capacity = 2300

Blade Angle Degree	T.P. at 2500 "water	Cap. at Max. Eff. C.F.M.	Max. Eff. %
0	1.65	2400	50.0
10	1.60	2350	48.2
15	1.53	2300	48.6
20	1.47	2300	46.4
25	1.405	2350	47.4
30	1.33	2200	46.5

10 Blades

Max. Eff. = 51.2%
Av. of Max. Eff. = 49.7%
Average Capacity = 2508

Blade Angle Degree	T.P. at 2500 "water	Cap. at Max. Eff. C.F.M.	Max. Eff. %
0	1.82	2700	50.9
10	1.74	2650	51.2
15	1.79	2500	50.5
20	1.63	2350	49.4
25	1.585	2350	48.6
30	1.50	2500	47.5

15 Blades

Max. Eff. = 52.5%
Av. of Max. Eff. = 51.5%
Average Capacity = 2375

Blade Angle Degree	T.P. at 2500 "water	Cap. at Max. Eff. C.F.M.	Max. Eff. %
0	1.80	2450	51.5
10	1.75	2350	52.5
20	1.63	2350	51.7
30	1.53	2350	51.5

30 Blades

Max. Eff. = 50.5%
Av. of Max. Eff. = 49.7%
Average Capacity = 2520

Blade Angle Degree	T.P. at 2500 "water	Cap. at Max. Eff. C.F.M.	Max. Eff. %
0	1.90	2650	50.5
10	1.71	2600	48.0
15	1.68	2350	50.3
20	1.65	2500	49.5
25	1.60	2500	50.1

Discussion of Results

The author wishes to direct attention to the tabulated sheet giving the results from curves. The streamlined blades proved inferior to the straight blades in all cases except those of the thirty blades. In this one particular instance the streamlined blades gave an increase of some six percent over that for either six, ten or fifteen streamlined blades and two percent above the best combination of straight blades.

It is interesting to note the general trend of efficiency with the number of blades. The straight blades reached their maximum when fifteen blades were used and the blade angle range used included the most favorable setting. The streamlined blades, however, were just beginning to show a decided improvement in efficiency with the thirty blades and the highest obtained was with the greatest backward angle used.

The capacity for the various number of blades remained approximately the same. The free area for air passing through the rotor, however, was materially reduced with the increase in the number of blades. A like effect was obtained by increasing the blade angle.

The above facts seem to indicate that streamlined blades are desirable only at relatively high velocities. Better restriction of the sides of the air streams would probably decrease the losses due to turbulence. This was partially effected with the greater number of blades.

The results indicate that an extended research with a greater number of blades and greater blade angle may prove interesting and beneficial.

The efficiency of the thirty blades was surprisingly greater than that for fewer number but the actual efficiency was so low that, probably under the best blade conditions, the fan would still give poor performance. A more promising field of research is most likely along the line of better housing and rotor design.

It is felt that the results are accurate to within 0.5% for comparative purposes. This statement is made with the knowledge of the accuracy of the readings and the consistancy of the results.

The author wishes to state that the method used for testing the fan proved very satisfactory. It is suggested that either or both the American Society of Mechanical Engineers and the American Society of Heating and Ventilating Engineers consider a code for testing centrifugal blower fans that embodies this method. The American Society of Mechanical Engineers has an acting committee for that purpose.

Calibration of Equipment - Driving Motor

A brake test was made on the driving motor to determine its efficiency. A prony brake and pulley wheel, placed on the motor shaft, were used to vary and measure the load. A recently calibrated wattmeter, the same one used in the fan tests, was used to measure the power input. The brake load was determined with a pair of Howe platform scales. The speed was determined by counting the revolutions with a Starret counter for one minute.

From the results a curve with kilowatts input and horsepower output as co-ordinates was plotted on a 15" by 18" cross-sectional graph sheet. This curve was used in the calculation of results in the fan test. A similar curve on a smaller scale, along with the speed and efficiency curves, is shown in this report.

Micro-Manometer

The manometer used has an inclined indicating glass tube to obtain sensitiveness but is not an inclined manometer. A very accurately machined screw, ten threads to the inch, elevates the glass tube. The head by which the screw is rotated is graduated in one hundred divisions. The amount of alcohol in the glass tube and rubber connection tube remains the same for any reading and, therefore, the zero reading for the manometer remains unchanged. Because of the type of manometer used no calibration of it was necessary.

Aug. 2, 1934 DATA AND RESULT SHEET N.C.Ebaugh
C.A.Short

For the Calibration of the Driving Motor

Motor No. 1470362 12 pole 3 phase 220 volts 600 R.P.M.

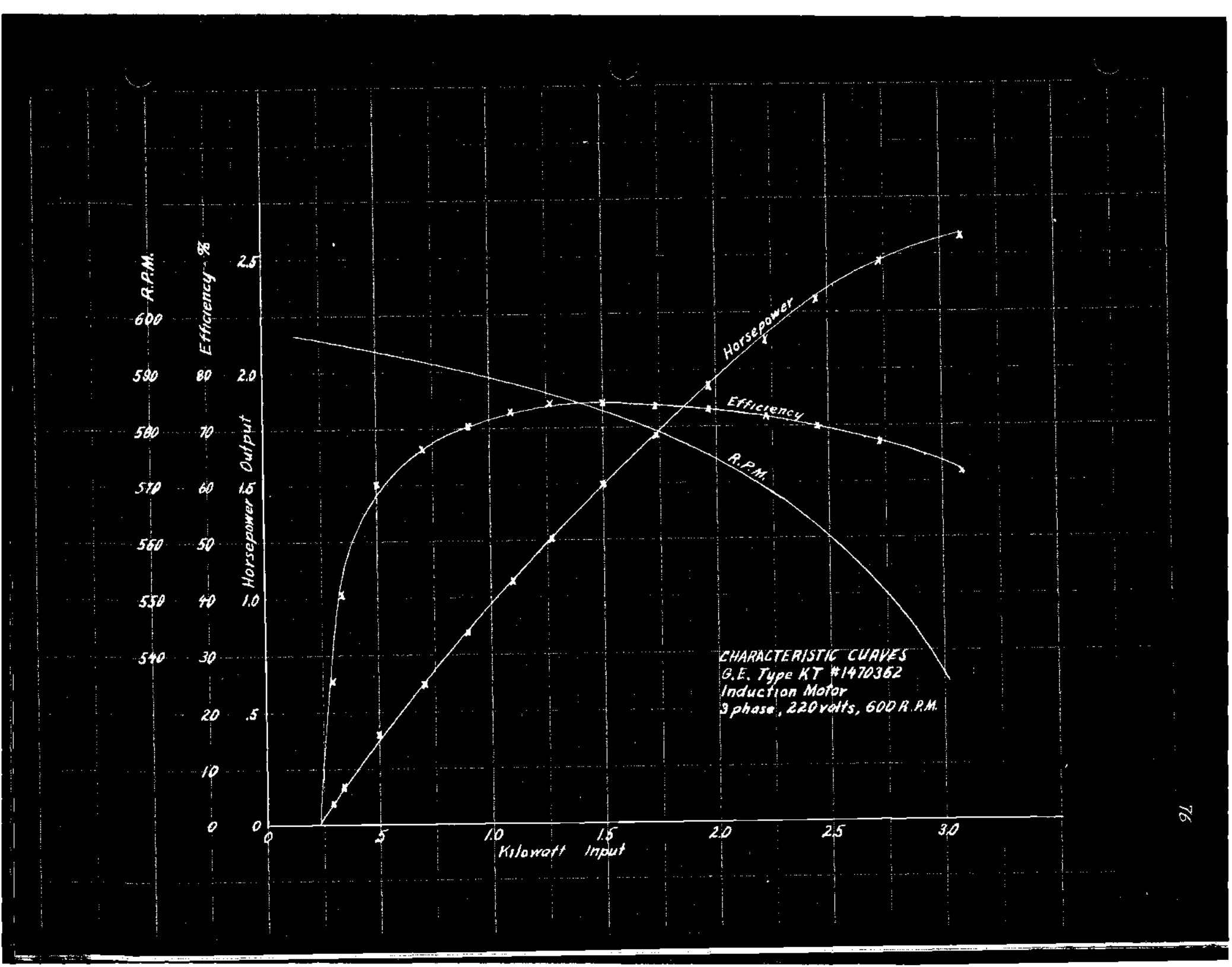
Brake load produced and determined by a prony brake.

Read No.	Voltage	Speed	Input	Gross Brake Load	Net Brake Load	Output	Efficiency
Units	Volts	R.P.M.	K.W.	Lbs.	Lbs.	Hp.	Percent
1	232	600	0.28	1.63	0.42	0.096	25.6
2	232	596	0.33	2.0	0.79	0.179	40.4
3	230	595	0.50	3.0	1.79	0.406	60.4
4	230	593	0.70	4.0	2.79	0.625	66.6
5	232	588	0.90	5.0	3.79	0.850	70.5
6	230	585	1.09	6.0	4.79	1.068	73.1
7	230	583	1.28	7.0	5.79	1.285	74.9
8	230	582	1.50	8.0	6.79	1.501	74.6
9	231	578	1.73	9.0	7.79	1.715	73.9
10	230	575	1.96	10.0	8.79	1.920	73.1
11	231	570	2.20	11.0	9.79	2.125	72.0
12	230	560	2.45	12.0	10.79	2.300	70.0
13	230	550	2.73	13.0	11.79	2.470	67.5
14	230	530	3.10	14.0	12.79	2.580	62.0

Brake tare forward = 1.48 Howe scales No. 4800
backward= 0.95
net = 1.21 lbs. Reads to 0.01 lbs.

Brake arm = 2.0 ft.

Hp. = $2\pi FLN \div 33000 = .000381FN$ F = net brake load
N = R.P.M.


R.P.M.
Efficiency - %
Horsepower Output
600
590
580
570
560
550
540
80
70
60
50
40
30
20
10
0
2.5
2.0
1.5
1.0
.5
0
Horsepower
Efficiency
R.P.M.
.5
1.0
1.5
2.0
2.5
3.0
Kilowatt Input
CHARACTERISTIC CURVES
G.E. Type KT #1470362
Induction Motor
3 phase, 220 volts, 600 R.P.M.

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